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SOCIETE ROYALE BELGE DE MALACOLOGIE

The genus *Gemixystus* Iredale, 1929 (Gastropoda: Muricidae: Trophoninae) in New Caledonia with the description of two new species and some notes on the genus in the Indo-West Pacific

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Keywords. Gastropoda, Muricidae, Trophoninae, *Gemixystus*, New Caledonia, new species.

ABSTRACT. The genus *Gemixystus* Iredale, 1929 in New Caledonia is reviewed. Five species are recorded of which two are new, *G. impolitus* n. sp. and *G. lenis* n. sp. *Gemixystus stimuleus* (Hedley, 1912) is recorded for the first time in New Caledonia. *Gemixystus transkeiensis* (Houart, 1987) is re-transferred from *Vaughtia* to *Gemixystus*. The 12 extant species of *Gemixystus* are illustrated.

INTRODUCTION

The genus *Gemixystus* in Australia and New Zealand was reviewed by Houart (2004) who included eight extant and six fossil species in this genus, of which *G. polyphyllius* (Tenison-Woods, 1879) is known from both extant and fossil specimens. A ninth extant species was described by Houart & Héros (2012) from the Chesterfield Reefs.

To date, molecular data of *Gemixystus* has not been analysed. In Barco et al. (2012) it was considered *incertae sedis*. We here provisionally retain *Gemixystus* in Trophoninae, pending future genetic analyses.

With the present revised classification, the new species described in 2012, and the two new ones described here, twelve extant species are currently assigned to *Gemixystus*: *G. calcareus* Houart & Héros, 2012, Coral Sea, Chesterfield Reefs; *G. fimbriatus* Houart, 2004, New South Wales, South Australia and Tasmania (Fig. 6A-B); *G. impolitus* n. sp., Chesterfield Reefs; *G. laminatus* (Petterd, 1884), South Queensland, Australia to Tasmania; *G. lenis* n. sp., Chesterfield Reefs; *G. leptos* (Houart, 1995), South Queensland, Australia and Chesterfield Reefs; *G. polyphillius* (Tenison-Woods, 1879), extant: New South Wales, Australia and S Tasmania; fossil: Miocene, Victoria (Fig. 6G-H); *G. recurvatus* (Verco, 1909), New South Wales, Australia and South Australia (Fig. 6I-J); *G. rhodanos* Houart, 2004, South Queensland, Australia to Tasmania (Fig. 6K-L); *G. rippingalei* (Houart, 1998), Queensland, Australia; *G. stimuleus* (Hedley, 1908), South Queensland and New South Wales, Australia; *G. trankeiensis* (Houart, 1987), Transkei, South Africa (Fig. 6N-P).

Adult shells of *Gemixystus* are small, rarely exceeding 7 mm in length. The largest being *G. laminatus* and *G. recurvatus* and the smallest *G. stimuleus*, the latter not exceeding 3.5 mm in length.

Material and methods

Material

The material studied here primarily includes specimens collected on various cruises conducted by the MNHN/IRD in New Caledonia. Other illustrated specimens are from the collections of the Australian Museum, Sydney, the KwaZulu-Natal Museum, South Africa, the South Australian Museum, Adelaide, the Tasmanian Museum, Hobart, and the personal collection of the first author.

Specimens from the following expeditions of the MNHN/IRD were examined: SMIB 8 (1993) DOI 10.17600/93000640 ; BATHUS 2 (1993) DOI 10.17600/93000360; BATHUS 3 (1993) DOI 10.17600/93000370; BATHUS 4 (1994) DOI 10.17600/94100030; NORFOLK 1 (2001) DOI 10.17600/1100050; EBISCO (2005) DOI 10.17600/5100080; KANACONO (2016) DOI 10.17600/16003900 ; KANADEEP (2017) DOI 10.17600/17003800.
These missions were aimed at exploring the seabed around New Caledonia and continuing the exploration in the Coral Sea with the Chesterfield Plateau and Bellona Reefs, as well as the Lansdowne-Fairway Reefs.

Morphological analyses
The characters used to describe shell morphology address the general aspect of the shell, its shape, size, and colour, the shape of the spire including the number and features of the protoconch and teleoconch whorls, details of the suture and of the subsutural ramp, details of axial and spiral sculpture, the aperture, the siphonal canal, and when available, the characters of the operculum and radula.
The method used to determine diameter and height, and to count the number of protoconch whorls, follows Bouchet & Kantor (2004) as shown in Fig. 1. The bathymetric ranges given herein are the inner values of the recorded depths: the deepest minimum and the shallowest maximum of each recorded depth range.

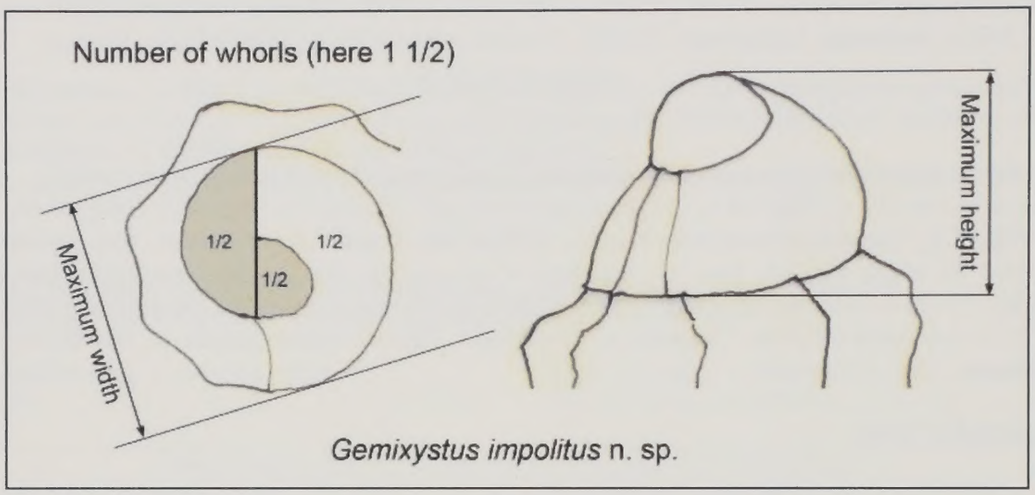


Figure 1. Method for determining diameter, height and counting the number of protoconch whorls.

ABBREVIATIONS

Repository

AMS: The Australian Museum, Sydney, Australia.
MNHN: Muséum national d'Histoire naturelle, Paris, France.
NM: KwaZulu-Natal Museum, Pietermaritzburg, South Africa.
RH: collection of Roland Houart.
SAMA: South Australian Museum, Adelaide, South Australia.
TAM: Tasmanian Museum.

Other

IRD: Institut de Recherche pour le Développement.

Station number prefixes

CP: Chalut à perche (beam trawl).
DW: Drague Warén (Warén dredge).

Specimens

dd: empty shell(s).
lv: live collected specimen(s).

Terminology used to describe the spiral cords and the apertural denticles (after Merle 2001, 2005) (Fig. 3A-F). Variable features are given in parentheses.

Convex part of teleoconch whorl and siphonal canal

ab: abapical (or abapertural);
ABP: abapertural primary cord on the siphonal canal;
ad: adapical (or adapertural);
ADP: adapertural primary cord on the siphonal canal;
MP: median primary cord on the siphonal canal;
P: primary cord;
P1: shoulder cord;
P2-P5: primary cords of the convex part of the teleoconch whorl;
s: secondary cord;
s1-s2: secondary cords of the convex part of the teleoconch whorl (s1 = secondary cord between P1 and P2; s2 = secondary cord between P2 and P3).

Aperture

D1 to D5: abapical denticles.

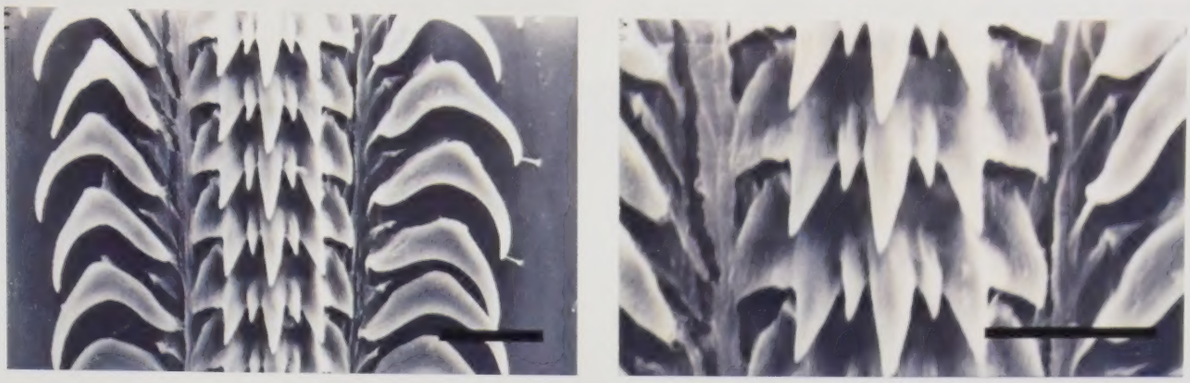


Figure 2. Radula of *Gemixystus leptos*. Holotype MNHN-IM-2000-970 (scale bar 10 µm).

SYSTEMATICS

Family **MURICIDAE** Rafinesque, 1815
Subfamily **TROPHONINAE** Cossmann, 1903
Genus ***Gemixystus*** Iredale, 1929
Type species by original designation: *Trophon laminatus* Petterd, 1884, Recent, southeastern Australia (Fig. 6C-F).
Apixystus Iredale, 1929. Type species by original designation: *Trophon stimuleus* Hedley, 1907, Recent, eastern Australia (Fig. 5K-T).

Remarks. Iredale (1929: 185) separated *Gemixystus* from *Apixystus* because of their different protoconch morphology, *Gemixystus* having an "angulate apex" (Fig. 6F) compared to the "smooth rounded apex" of *Apixystus* (Fig. 5S-T). However, such differences in Muricidae are now considered to be a useful tool at the specific level only. The two taxa were recognized as congeneric by Houart (2004).
He also transferred two South African species formerly described in *Apixystus* Iredale, 1929, a synonym of *Gemixystus*, to other genera and subfamilies. *Apixystus kilburni* Houart, 1987 was transferred to *Pazinotus* Vokes, 1970 (Muricopsinae) and *A. transkeiensis* Houart, 1987 to *Vaughtia* Houart, 1995 (Ocenebrinae). This new classification was taken over by Houart et al. (2010).
The classification of *A. kilburni* in *Pazinotus* is not questioned, but *A. transkeiensis* is here reintroduced to *Gemixystus* after a re-examination of the material. The small, light shell of *G. transkeiensis* with a broad last teleoconch whorl strongly constricted at base, a broad aperture and an expanded apertural varix; a long, open, siphonal canal and a spiral sculpture consisting of 9-11 axial lamellae on the last teleoconch whorl, together with the broad, broadly open spinelets at intersection of the axial lamellae and the five rounded, spiral cords have prompted us to review its classification.

Gemixystus calcareus Houart & Héros, 2012
Figs 3A; 4A-B

Gemixystus calcareus Houart & Héros, 2012: 30, fig. 2C, D, N

Type locality. Coral Sea, Chesterfield Reefs, 19°36'S, 158°43'E, 568-570 m [EBISCO: stn DW2603].

Type material. Holotype (dd) MNHN-IM-2000-24180.

Other material examined. New Caledonia, Coral Sea, Chesterfield Reefs, EBISCO, stn DW2603, 19°36'S, 158°43'E, 568-570 m, 4 dd, MNHN-IM-2012-41629, 1 dd, RH.

Distribution. Only known from empty shells from the type locality.

Original description. Shell medium-sized for the genus, height 5.4 mm, height/width ratio 1.7. Broadly-ovate, lightly built, lamellate. Subsutural ramp narrow, weakly sloping, weakly convex. Shell entirely chalk-white. Spire high with 1.6 protoconch whorls and 4.2 broad, weakly shouldered teleoconch whorls. Suture of teleoconch whorls impressed, partially obscured by small axial lamellae of following whorl. Protoconch comparatively large, broad, weakly acuminate with broad keel adapically, otherwise smooth. Diameter 500 µm. Terminal lip delicate, thin, weakly curved.
Axial sculpture of teleoconch whorls consisting of low, narrow, frilled lamellae, each with short, broad, open spinelets occurring at crossings of axial lamellae with spiral cords. Spines more conspicuous on P1. First whorl with 8 lamellae, 2nd with 13, 3rd with 16 and 4th with 20. Apertural lamella strongly erect, broad. Spiral sculpture of low, broad, rounded primary cords: P1-P3 visible on 1st to 3rd whorl with slightly visible, very narrow P2. P3 partially covered by following whorl. Last teleoconch whorl with P1-P5, ADP, MP. P1-P5 equidistant, P1 slightly larger, P2 narrow. ADP and MP narrower, MP low.
Aperture broad, rounded. Columellar lip narrow, smooth. Lip adherent at adapical extremity. Anal notch obsolete. Outer lip strongly erect with five weak, elongate denticles within: D1-D5. D4 and D5 narrower, more strongly elongate within. Siphonal canal short, narrow, straight, open, with ADP and MP and low axial lamellae over whole length.

Remarks. *Gemixystus calcareus* differs from *G. stimuleus* in having a comparatively larger shell with twice as large protoconch, more numerous axial lamellae, 20 *vs* 11 or 12 on last whorl and 16 *vs* 13-15 on penultimate whorl. The spiral sculpture also differs, *G. calcareus* having P1-P5, ADP and MP on the last teleoconch whorl *vs* P1-P3 in *G. stimuleus,* without any spiral sculpture on the siphonal canal.
Gemixystus calcareus also differs from *G. rippingalei* (Figs 3E, 6M) from Queensland, Australia, in having a comparatively larger shell, *G. rippingalei* reaching only 4.4 mm in length and having a longer siphonal canal; also in having a less spiny shell and different spiral sculpture morphology. *G. rippingalei* having a last whorl with closely spaced P1-P4.

Gemixystus impolitus n. sp.
Figs 3B; 4C-H

Material examined. New Caledonia, **Coral Sea**, Lord Howe Rise, Banc Capel, KANADEEP, stn CP4934, 25°04'S, 159°55'E, 290-300 m, 1 dd, holotype MNHN-IM-2000-34501; Banc Kelso, stn DW4949, 24°07'S, 159°41'E, 280-300 m, 1 dd, paratype MNHN-IM-2000-34502; Banc Nova, stn DW5011, 22°07'S, 159°19'E, 340-550 m, 1 dd, paratype MNHN-IM-2000-34503

Other material examined. Coral Sea, South Landsdowne, EBISCO stn DW2629, 21°06'S, 160°46'E, 569-583 m, 1 dd.

Type locality. Coral Sea, Lord Howe Rise, Banc Capel, 25°04'S, 159°55'E, 290-300 m.

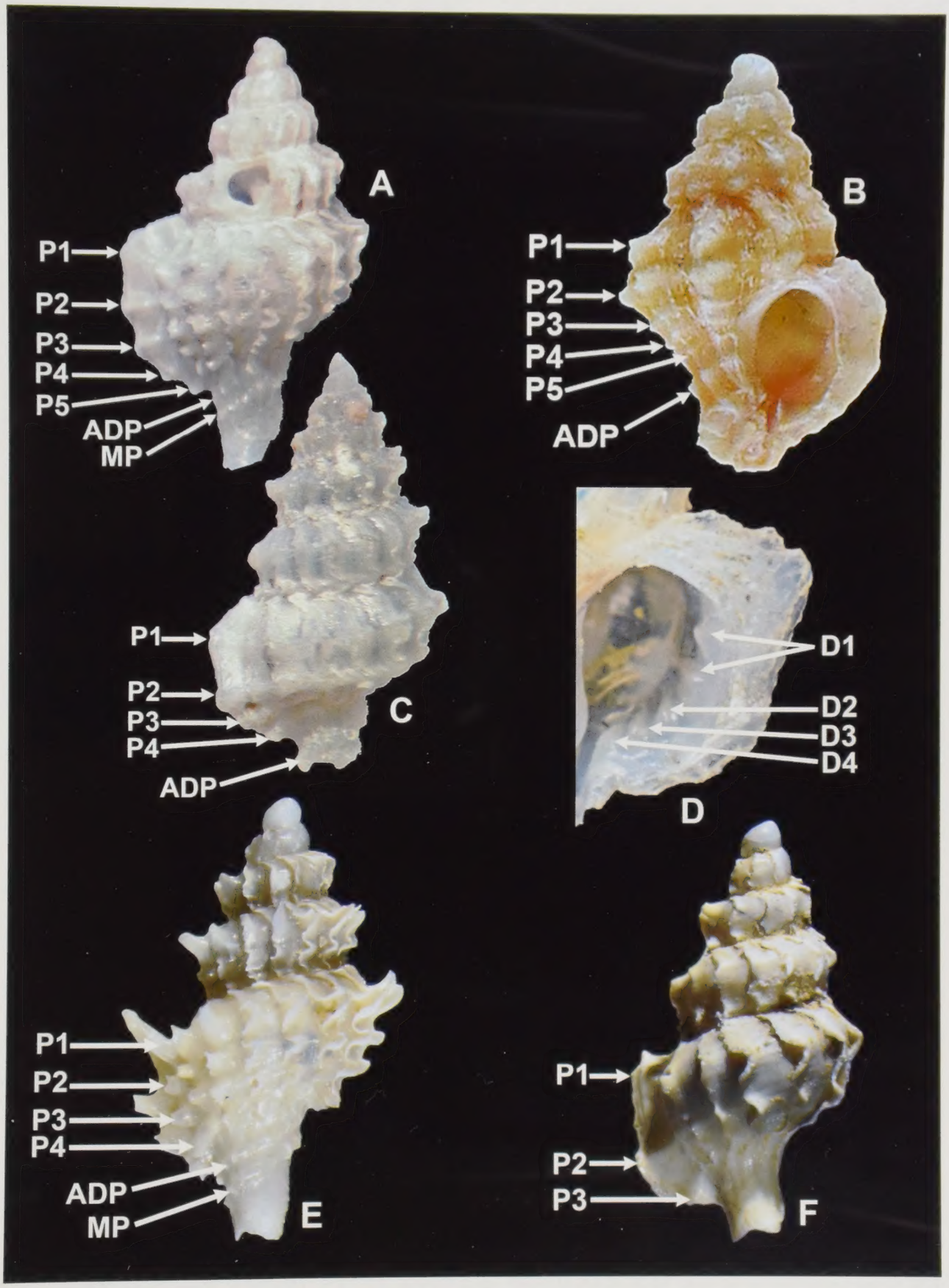
Distribution. Lord Howe Rise: Bancs Capel, Kelso and Nova and South Landsdowne, empty shells at 300-569 m.

Description of the holotype. Shell small, 4 mm in length. Length/width ratio 1.7. Biconical, broadly ovate. Heavy, weakly spinose, squamous, angulate. Subsutural ramp broad, strongly sloping, weakly convex.
Ivory white to light tan with darker coloured subsutural area. Aperture white.
Spire high with 1.5 protoconch whorls. Teleoconch of 3.5 broad, angulate, strongly shouldered, weakly spinose whorls. Suture of whorls impressed. Protoconch large, broad. Whorls rounded, smooth. Maximum width 400 µm, height 500 µm. Terminal lip shallow, thin, weakly opisthocline.
Axial sculpture of teleoconch whorls consisting of moderately high, narrow, nodose, weakly spinose varices; each varix with nodes and small, open spinelets. Other axial sculpture of numerous, low, narrow growth lamellae. Seven varices on first and second whorls, 5 on last. Spiral sculpture of low, rounded, narrow, squamous primary and secondary cords, with weakly broader P1 and P2, followed abapically by lower P3-P5 and ADP. Low s1 secondary cord between P1 and P2, and s2 between P2 and P3. Crossing of P1 and P2 with axial varices giving rise to short, open, acute spinelets, less conspicuous on apertural varix. P3-P5 weakly nodose on varices.
Aperture moderately large, roundly ovate. Columellar lip narrow, with 2 weak, small knobs abapically; rim broken. Anal notch very broad, shallow. Outer lip narrow, weakly erect, with weak, narrow, elongate D3 and D4; D1 and D2 obsolete. Siphonal canal short, narrow, slightly dorsally recurved, open.
Operculum and radula unknown.

Remarks. This new species is somewhat atypical for the genus, in having broader varices instead of axial lamellate varices as in the other species. However it is here included in *Gemixystus* because of its biconical small shell with a broadly ovate aperture with typical, narrow, elongate denticles within the outer lip. These denticles are mostly situated at adapical part of the aperture, with a strong, elongate D4 and absent ID and D1. The shell also has a typical, broad, expanded, apertural varix and a broadly open, short, siphonal canal.

Figure 3. Spiral sculpture and apertural denticles morphology

A. *Gemixystus calcareus* Houart & Héros, 2012. Chesterfield Plateau, 19°36' S, 158°43' E, 568-570 m, RH, 4.9 mm.
B. *Gemixystus impolitus* n. sp. KANADEEP, stn CP4934, 25°04'S, 159°55'E, 290-300 m, holotype MNHN-IM-2000-34501, 4 mm.
C-D. *Gemixystus leptos* (Houart, 1995). C. Coral Sea, 19°40' S, 158°27' E, 245-252 m, holotype MNHN-IM-2000-970, 4.8 mm; D. KANACONO, stn DW4695, North Iles des Pins, 22°47' S, 167°27' E, 200-290 m, MNHN, 5.1 mm.
E. *Gemixystus rippingalei* Houart, 2004. Australia, Queensland, E of Lady Musgrave Island, 23°62.5'-23°51.9' S, 152°427'-152°41.7' E, 296 m, holotype AMS C.313232, 4 mm (photo Alison Miller, AMS).
F. *Gemisxystus stimuleus* (Hedley, 1908). New South Wales, Sydney, 22 miles east of Narraben, 146 m, holotype AMS C.25787, 3.0 mm (photo Alison Miller, AMS).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P1
P2
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D1
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E
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ADP
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F
P1
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P3

A paratype of 4.8 mm, also with 3.5 teleoconch whorls (Fig. 4E-F) is entirely light brown coloured. It has three denticles within the outer apertural lip (D2-D4) with obsolete D1, a broader protoconch of 600 µm high and wide. The spiral and axial sculpture as well as the apertural denticles are more conspicuous but otherwise are similar to the holotype.
Gemixystus stimuleus (Fig. 5K-T) differs by its lighter shell with narrow, more numerous lamellae, by the absence of any other axial sculpture, by the three spiral cords on the last teleoconch whorl instead of five in *G. impolitus* n. sp. and in having a narrower and smooth siphonal canal.

Etymology. *Impolitus* (L), unpolished, rough, named for the rough appearance of the shell.

Gemixystus lenis n. sp.
Fig. 4I-N

Material examined. New Caledonia, Coral Sea, Lord Howe Rise, Banc Argo, KANADEEP, stn DW4956, 23°13'S, 159°35'E, 295 m, 1 dd, holotype MNHN-IM-2000-34504; Banc Kelso, stn DW4951, 24°12'S, 159°41'E, 270-385 m, 1 lv, 1 dd, paratypes MNHN-IM-2000-34505 (syntopic with *G. leptos*).

Type locality. Coral Sea, Lord Howe Rise: Banc Argo, 23°13'S, 159°35'E, empty shells at 295 m.

Distribution. Coral Sea: Bancs Argo and Kelso, living at 270 m.

Description of the holotype. Shell very small, 2.9 mm in length. Length/width ratio 1.6. Biconical, broad, smooth, lightly built. Subsutural band narrow, weakly sloping, weakly convex.
Shell entirely white.
Spire high with 1.75 protoconch whorls and teleoconch consisting of 3 broad, weakly convex, weakly shouldered whorls. Suture of whorls impressed. Protoconch large, weakly elongate, whorls longitudinally keeled, otherwise smooth. Maximum width 450 µm, height 500 µm. Terminal lip low, delicate, thin, weakly prosocline.
Axial sculpture of teleoconch whorls consisting of low, weak, narrow lamellae. Apertural lamellae broad, flaring. First and second whorls with 7 lamellae, last whorl has 6 with a broad space between penultimate and last lamellae. No trace of spiral sculpture except low P1 giving rise to small, broad, low, open spines at intersection with axial lamellae.
Aperture large, broad, roundly ovate. Columellar lip broad, smooth, rim weakly erect, a small portion adherent at adapical extremity. Anal notch shallow, very broad. Outer lip narrow, weakly erect, with 4 strong, elongate denticles within, consisting of D1-D4 with D1 highest and broadest. Siphonal canal short, narrow, weakly dorsally recurved, broadly open.
Operculum and radula unknown.

Remarks. The holotype is subadult and both paratypes are also juveniles of 2.1 and 2.3 mm in length, consisting of two teleoconch whorls and featuring all the characteristics of the holotype.
Gemixystus lenis n. sp. differs from all the other *Gemixystus* species in lacking any spiral sculpture except a low P1 cord and in having a wide distance between the penultimate and the last varix.

Etymology. *Lenis* (L), smooth, soft, named for the smooth shell.

Gemixystus leptos Houart, 1995
Figs 3C-D; 5A-J

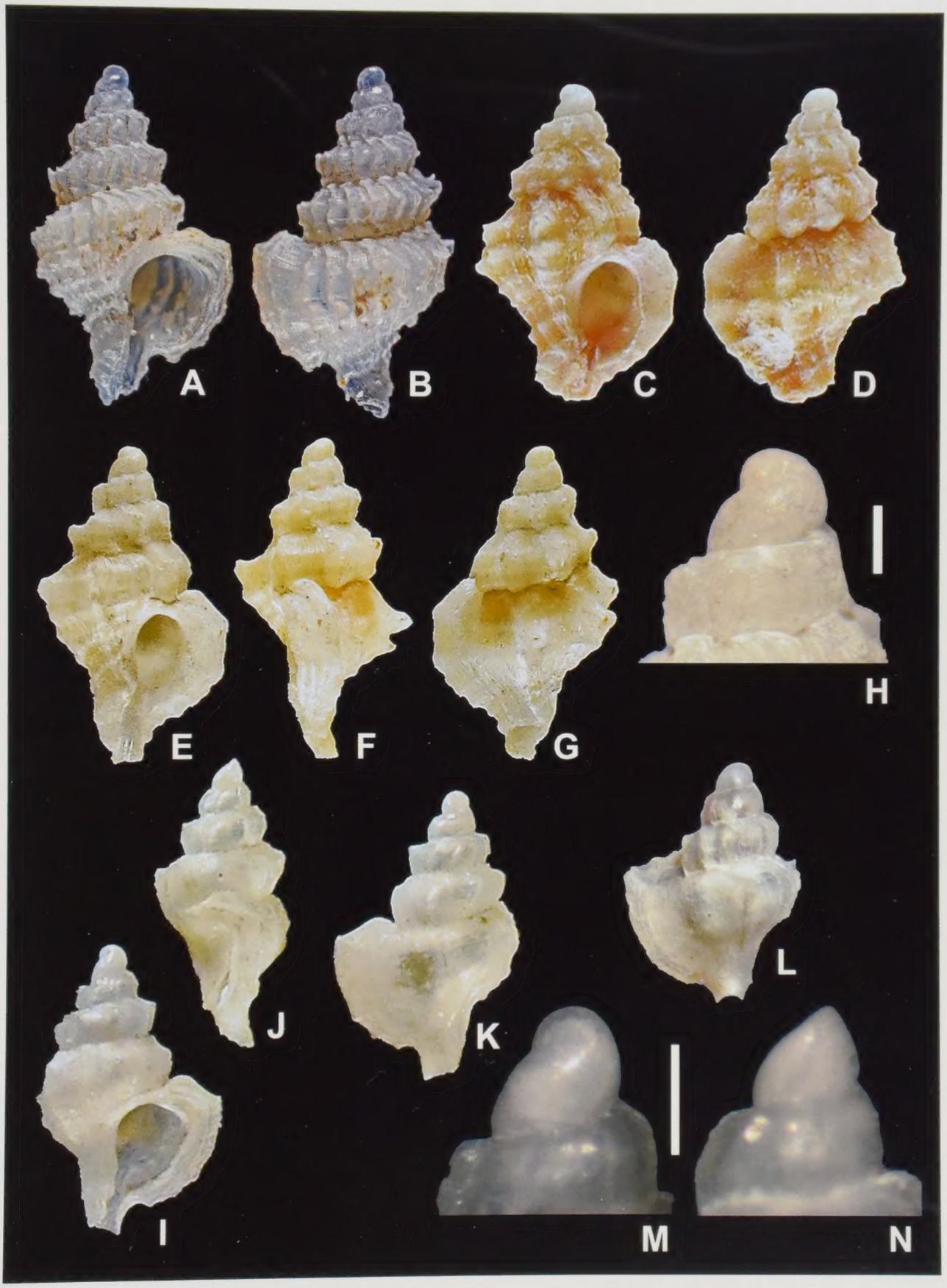
Apixystus leptos Houart, 1995: 490, figs 28-29, 86-89,134-136.

Apixystus leptos — Houart, 1998: 100, figs 18-19.
Gemixystus leptos — Houart, 2004: 6, figs 5-7, 9-11, 22, 30-32, 37.
Gemixystus leptos — Houart & Héros, 2012: 31, fig. 2G.

Type locality. Coral Sea, Chesterfield Plateau, 19°40'S, 158°27'E, 245-252 m, lv [MUSORSTOM 5: stn DW346]

Figure 4. Scale bars 250 µm.

A-B. *Gemixystus calcareus* Houart & Héros, 2012. Coral Sea, Chesterfield Reefs, 19°36'S, 158°43'E, 568-570 m, holotype MNHN-IM-2000-24180, 5.4 mm.
C-H. *Gemixystus impolitus* n. sp. C-D, H. KANADEEP, stn CP4934, 25°04'S, 159°55'E, 290-300 m, holotype MNHN-IM-2000-34501, 4 mm; H. Protoconch; E-F. KANADEEP, stn DW5011, Banc Nova, 22°07' S, 159°19' E, 340-550 m, paratype MNHN-IM-2000-34503, 4.8 mm.
I-N. *Gemixystus lenis* n. sp. I-K, M-N. KANADEEP, stn CP4956, 23°13' S, 159°35' E, Banc Argo, 295 m, holotype MNHN-IM-2000-34504, 2.9 mm; M-N. Protoconch; L. KANADEEP, stn DW4951, Banc Kelso, 24°12' S, 159°41' E, 270-385 m, paratype MNHN-IM-2000-34505, 2.2 mm.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Type material. Holotype MNHN-IM-2000-970.

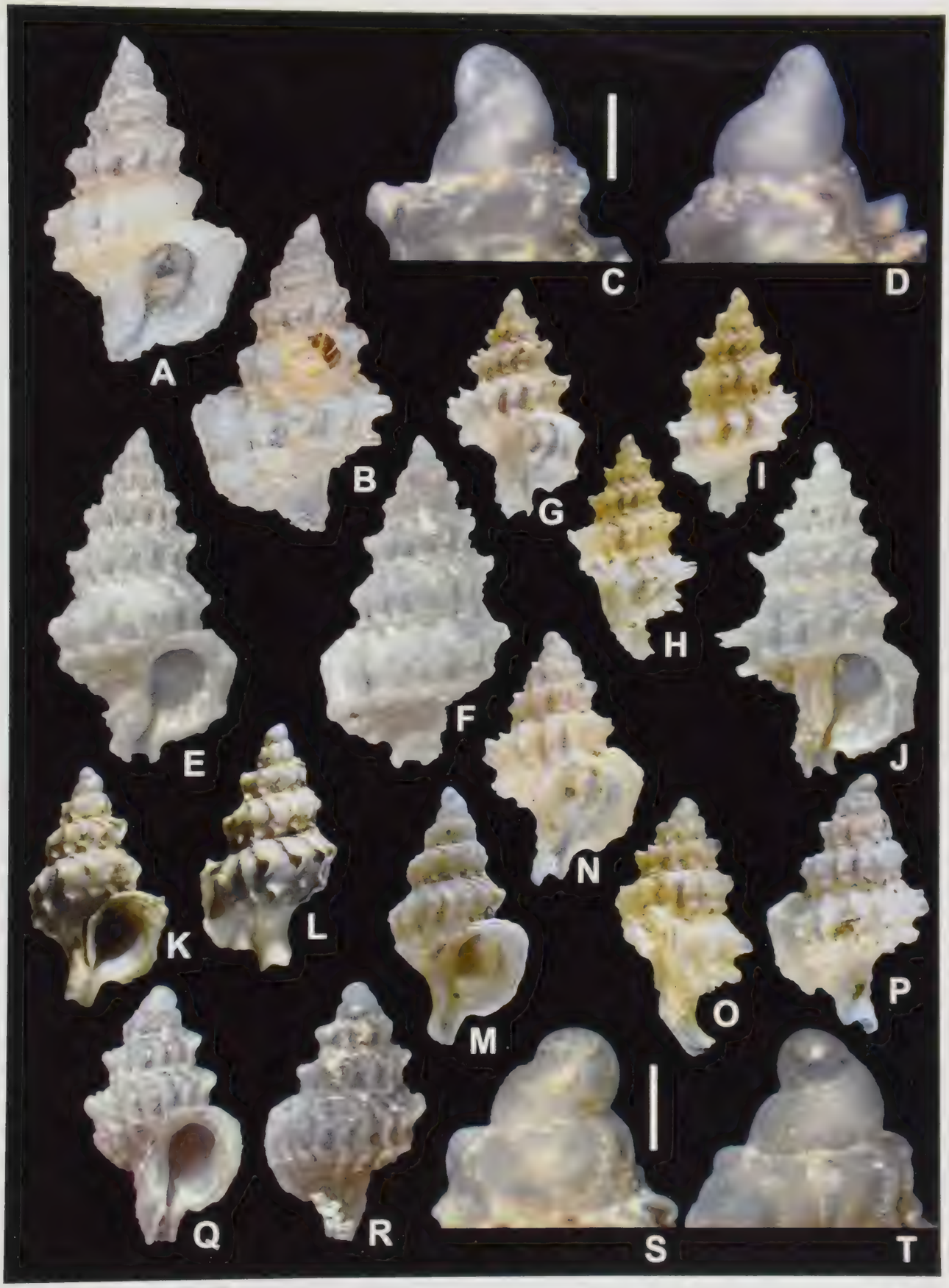
Other material examined. New Caledonia. Coral Sea, between Chesterfield and Bellona Reefs, EBISCO, stn DW2574, 20°20'S, 158°45'E, 358-374 m, 2 dd; Lansdowne-Fairway Reefs: stn DW2617, 20°06'S, 160°22'E, 427-505 m, MNHN-IM-2017-256, 1 lv; stn DW2632, 21°05' S, 160°45' E, 297-378 m, 13 dd.
Banc Kelso, KANADEEP, stn DW4951, 24°12'S, 159°41'E, 270-385 m, 1 dd (syntopic with *G. lenis* n. sp.); stn DW4954, 24°12'S, 159°41'E, 300 m, 1 dd.
North of New Caledonia, Grand Passage, BATHUS 4, stn DW918, 18°49'S, 163°16'E, 613-647 m, MNHN-IM-2012-33083, 1 dd.
Norfolk Ridge, South of New Caledonia, SMIB 8, stn DW166, 23°38'S, 167°43'E, 433-450 m, MNHN-IM-2012-33088, 1 dd; stn DW167, 23°38'S, 167°43'E, 430-452 m, MNHN-IM-2012-33007, 1 lv; stn DW169, 23°37'S, 167°42'E, 447-450 m, MNHN-IM-2012-33086, 2 lv; stn DW 170-172, 23°41'S, 168°00'-168°01'E, 230-290 m, 1 dd; stn DW182-184, 23°18'-23°19'S, 168°05'E, 305-367 m, MNHN-IM-2012-32982, 2 lv, 4 dd; stn DW190, 23°18'S, 168°05'E, 305-310 m, MNHN-IM-2012-32983, 4 dd.
BATHUS 2, stn DW714, 22°38'S, 167°10'E, 124 m, MNHN-IM-2017-362, 3 dd;, MNHN-IM-2014-2453, 1 dd; stn DW715, 22°39'S, 167°11'E, 202-227 m, MNHN-IM-2012-33085, 1 dd; stn DW724, 22°48'S, 167°26'E, 344-358 m, MNHN-IM-2010-4899, 1 dd;
BATHUS 3, stn CP805, Banc Jumeau Ouest, 23°41'S, 168°01'E, 278-310 m, MNHN-IM-2012-32986, 1 lv; stn DW809, Banc Jumeau Ouest, 23°39'S, 167°59'E, 650-730 m, MNHN-IM-2012-32984, 2 dd; stn DW824, Nord Banc Antigonia 23°19'S, 168°00'E, 601-608 m, MNHN-IM-2012-32985, 2 dd; stn DW829, Nord Banc Antigonia , 23°21'S, 168°02'E, 386-390 m, MNHN-IM-2012-33084, 1 dd.
NORFOLK 1, stn DW1722, Banc Antigonia, 23°16'S, 168°01'E, 540-540 m, MNHN-IM-2012-9285, 1 dd; stn DW1723, Banc Crypthelia, 23°18'S, 168°15'E, 267-266 m, MNHN-IM-2012-9246, 2 dd.
NORFOLK 2, stn DW2040, Banc Jumeau Ouest, 23°41'S, 168°01'E, 285 m, MNHN-IM-2012-9298, 2 dd.
KANACONO, stn DW4677, 22°53'S, 167°35'E, 376-390 m, 1 dd; stn DW4685, 22°28'S, 167°29'E, 404-405 m, 1 dd; stn DW4686, 22°29'S, 167°31'E, 249-255 m, 1 dd; stn DW4695, 22°47'S, 167°27'E, 200-290 m, 1 dd.

Distribution. South Queensland, Australia to the Coral Sea and the Norfolk Ridge. Only recorded dead in Australia, from 31-73 m; New Caledonia, recorded alive in 124-447 m.

Original description. Shell up to 4.9 mm in length (AMS C150077), spinose, delicate. Spire high with 1.75 protoconch whorls and up to 5 angulate, shouldered, spinose teleoconch whorls. Protoconch acuminate, rounded or keeled, whorls smooth, glossy; terminal varix erect, delicate, thin. Suture impressed. Axial sculpture consisting of sharp, erect lamellae. First whorl with 10 or 11 lamellae, second and third whorls with 11 lamellae, last whorl with 10 or 11 lamellae. Spiral sculpture consisting of weak, rounded cords. First to fourth teleoconch whorls with visible, broadly spaced P1 and P2; last whorl with broadly spaced P1 and P2, followed abapically by narrow, closely spaced, low P3 and P4. Last whorl of a few specimens with s1 between P1 and P2 (AMS C.321889). Short to moderately long, narrow, open spinelets occurring at crossing of axial and spiral sculpture. Spine on P1 longest.
Anal notch obsolete. Outer apertural lip smooth, with 5 strong, narrow, strongly elongate denticles within: D1 (split), D2, D3 (split). Siphonal canal short, 9-11% of total shell length, narrow, weakly abaxially bent, open, smooth. Translucent milky white with traces of pale brown on last teleoconch whorl. Rachidian radular tooth with long central and marginal cusps and short lateral denticles. Lateral teeth sickle-shaped. Aperture rounded. Columellar lip flaring, smooth, partially erect, weakly adherent at adapical extremity.

Figure 5. Scale bars 250 µm

A-J. *Gemixystus leptos* (Houart, 1995). A-B. Coral Sea, 19°40' S, 158°27' E, 245-252 m, holotype MNHN-IM-2000-970, 4.8 mm; C-D. Protoconch, BATHUS 2, stn DW714, 22°38' S, 167°10' E, 124 m, MNHN-IM-2014-2453; E-F. KANACONO, stn DW4695, North Iles des Pins, 22°47' S, 167°27' E, 200-290 m, MNHN, 5.1 mm; G-I. SMIB 8, stns DW182-184, 23°18' - 23°19' S, 168°05' E, 305-367 m, MNHN-IM-2012-32982, 3.7 mm; J. SMIB 8, stns DW170-172, 23°41° S, 168°00' - 168°01' E, 230-290 m, MNHN, 5.1 mm.
K-T. *Gemixystus stimuleus* (Hedley, 1908). K-L. New South Wales, Sydney, 22 miles east of Narraben, 146 m, holotype AMS C.25787, 3.0 mm (photo Alison Miller, AMS); M. Australia, QLD, NE of Cape Moreton, 26°54'-26°57' S, 153°32' - 153°35' E, 115-124 m, RH, 3.4 mm; N-P, S-T. SMIB 8, stns 146-147, 22°55' S, 168°22' E, 508-532 m, MNHN-IM-2012-33087, 3.5 mm; S-T. Protoconch; Q-R. KANADEEP, Banc Argo, 23°02' S, 159°28' E, 315-1260 m, MNHN, 3.4 mm.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Remarks

Gemixystus leptos differs from *G. stimuleus* in having a smaller, sharper, acute, shouldered, or more or less keeled protoconch (Figs 5C-D; 5S-T); the spire is higher with comparatively narrower spire whorls. *G. leptos* also has a broader subsutural ramp, narrower spines and more widely spaced P1-P2, the shell is more strongly angulate and the outer apertural lip is more strongly denticulate within with P1, P2, P3, P4 of which some are split as opposed to P1, P2, P3 in *G. stimuleus.*
Only empty shells were recorded from South Queensland and in shallower depths than the New Caledonian shells (Houart, 2004). However no significant differences were detected between the two populations. The maximum length of 4.9 mm observed in 2004 is now increased to 5.3 mm in a specimen collected in New Caledonia.

Gemixystus stimuleus (Hedley, 1907)
Figs 3F; 5K-T

Trophon stimuleus Hedley, 1907: 293, pl. 55, fig. 19.

Type locality. New South Wales, Sydney, 22 miles east of Narrabeen, 146 m.

Type material. Holotype AMS C.25787.

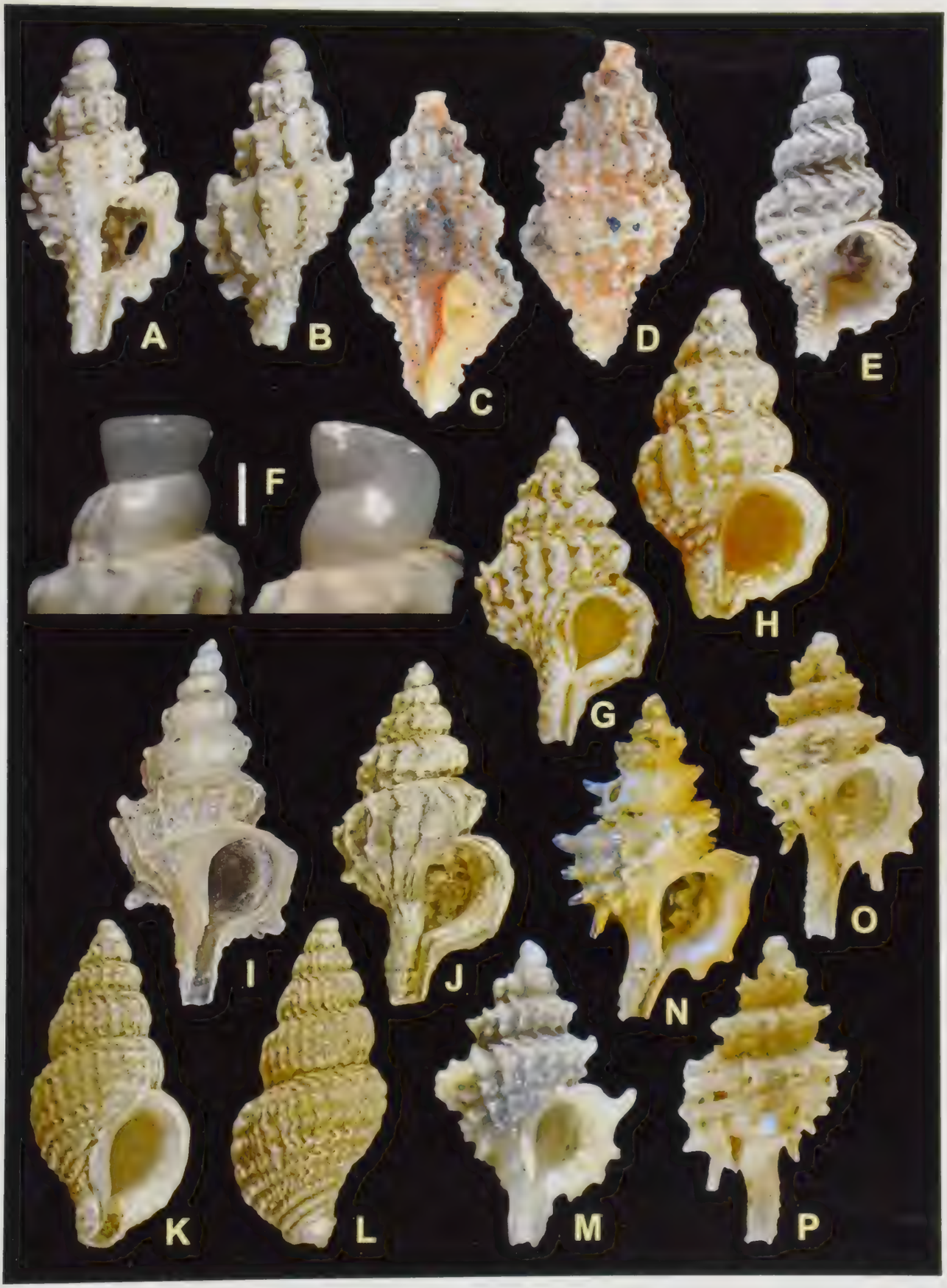
Other material examined. Australia, Queensland, off Cape Moreton, 128-183 m, 5 dd (AMS C.150076), NE of Cape Moreton, 26°54' - 26°57'S, 153°32' - 153°35'E, 115-124 m, 16 dd (AMS C.321981), 1 dd (RH) (in Houart, 2004).
South of New Caledonia, **Norfolk Ridge**, SMIB 8, stns DW146-147, 24°55'S, 168°22'E, 508-532 m, MNHN-IM-2012-33087, 6 lv, 11 dd.
BATHUS 3, stn DW818, 23°44'S, 168°16'E, 394-401 m, MNHN-IM-2012-32987, 2 lv, 1 dd.
NORFOLK 1, stn DW1692, Banc Eponge, 24°55'S, 168°20'E, 507-967 m, MNHN-IM-2012-33082, 1 lv, 1 dd.
Coral Sea, Lord Howe Rise, KANADEEP, stn DW4951, 24°12'S, 159°41'E, 270-385 m, 1 dd; stn DW4962, Banc Argo, 23°02'S, 159°28'E, 315-1260 m, 4 dd.

Distribution. Australia: South Queensland and Sydney, New South Wales, 115-183 m (dd); New Caledonia (new distribution record): Coral Sea and Norfolk Ridge, collected alive in 401-508 m.

Description (from Houart, 2004). Shell up to 3.5 mm in length at maturity, biconical. Spire high with 1.5 protoconch whorls, and up to 4 broad, weakly shouldered teleoconch whorls. Suture impressed, partially obscured by small axial lamellae of following whorl. Protoconch large, broadly elongate. Whorls rounded, smooth; terminal varix unknown (eroded in examined specimens).
Axial sculpture of teleoconch whorls consisting of high, strong, webbed lamellae: 9 on first whorl, 12 on second, 15 on third, 11 or 12 on last whorl. Spiral sculpture of rounded cords: visible spiral sculpture of first, second and third whorls of P1-P2; last whorl with P1-P3, decreasing in strength abapically.
Aperture large, broad, rounded. Columellar lip broad, flaring, smooth, lip partially erect, adherent at adapical extremity. Anal notch obsolete. Outer lip broad, with 2 weak, broad, low denticles within. Siphonal canal short, 18-20% of total shell length, narrow, smooth. Creamy white.

Figure 6. Scale bar 250 µm.

A-B. *Gemixystus fimbriatus* Houart, 2004. Tasmania, E of D'Entrecasteaux Channel, 44°2.2'S, 146°50.5'E, 176 m, holotype AMS C.322414, 4.1 mm (photo Alison Miller, AMS).
C-F. *Gemixystus laminatus* (Petterd, 1884). C-D. Tamar Heads, Tasmania, holotype TM E824/8165, 4.9 mm (photo Simon Grove, TAM); E-F. Australia, Victoria, 30 km SW of Cape Everard, 38°4'S, 149°9'E, 119 m, RH, 4.6 mm; F. Protoconch.
G-H. *Gemixystus polyphyllius* (Tenison-Woods, 1879). G. Victoria, Muddy Creek, near Hamilton, 37°44'S, 141°56'E, Miocene, holotype AMS C.170873, 5.1 mm; H. Australia, Victoria, Gabo Is. 37°34'S, 149°55'E, 21 m, AMS C322366, 5.4 mm (photo Alison Miller, AMS).
I-J. *Gemixystus recurvatus* (Verco, 1909). I. South Australia, 200 fathoms of Beachport, holotype SAMA D13484, 6.7 mm (photo Shirley Sorokin, SAMA); J. New South Wales, off Sydney, 384 m, AMS C150080, 7 mm (photo Alison Miller, AMS).
K-L. *Gemixustus rhodanos* Houart, 2004. Australia, NSW, 2.3 km E of Malabar, Sydney. 33°59.45'S, 151°16.8'E, 66 m, holotype AMS C.322835, 5.9 mm (photo Alison Miller, AMS).
M. *Gemixystus rippingalei* (Houart, 1998). Australia, Queensland, E. of Lady Musgrave Is, 23°62.5' - 23°51.9'S, 152°42.7' - 152°41.7'E, 296 m, holotype AMS C313232, 4 mm (photo Alison Miller, AMS).
N-P. *Gemixystus transkeiensis* (Houart, 1987). N. South Africa, N Transkei, off Nthlonyane R., 32°17.5'S, 29°03.9' E, 130 m, coarse brown sand, old calcareous fragments, holotype NM C5902, 5.1 mm (photo NM); O-P. South Africa, Transkei, off Mtamvuna River, 31°10'S, 30°15'E, 120-140 m, paratype RH, 4.5 mm.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Remarks. *Gemixystus stimuleus* is now also recorded from New Caledonia, in greater depths than in Australia, but except for a slightly lower spire and occasionally more numerous axial varices, no other significant differences were identified.

The New Caledonian form also resembles *G. rippingalei* (Houart, 1998) (Fig. 3E; 6M), but *G. rippingalei* has a more evenly biconical shell with obvious, narrower P1-P4 spiral cords on the last teleoconch whorl and ADP, MP on the siphonal canal. P1-P4 ending as narrow, open spinelets on the axial varices, more obvious on the apertural varix with a longer, narrow P1 spine and shorter P2-P4 spines of same length. The aperture is also different, being more ovate in *G. rippingalei* with 4 narrow D1-D4 denticles within the outer lip, as opposed to a rounded aperture with lower denticles in *G. stimuleus*.

Gemixystus stimuleus from New Caledonia has the typical sculpture of the species, with relatively broad, more spaced P1-P2 cords and a narrow and shallow P3 cord, ending as broad, short open spinelets on the varices, shorter or obsolete on the apertural varix. The siphonal canal is smooth.

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New species of Conradiidae Golikov & Starobogatov, 1987 (= Crosseolidae Hickman, 2013) (Gastropoda: Trochoidea) from the Tropical Indo-Pacific – I. The genus *Crossea*

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KEYWORDS. Gastropoda, Trochoidea, Conradiidae, Crossea, Indo-Pacific, new species.

ABSTRACT. New species of crosseolid vetigastropods, obtained during several expeditions in the Indo-West Pacific organized by MNHN and IRD, are studied. In the present work (part I) thirteen species of the genus *Crossea* A. Adams, 1865 are studied, of which eleven are new, described and figured here. All these species are compared with the previously known species in this genus.

RESUMEN. Se han estudiado nuevas especies de vetigastrópodos crosseólidos obtenidos en varias expediciones en el Oeste del Indopacífico organizadas por el MNHN y IRD. En el presente trabajo (parte I) se estudian 13 especies del género *Crossea* A. Adams, 1865, de las cuales 11 son nuevas, siendo descritas y representadas aquí. Todas estas especies son comparadas con las previamente conocidas en este género.

INTRODUCTION

The genus *Conradia* was proposed by A. Adams (1860), who designated *Conradia cingulifera* A. Adams, 1860 as the type species and placed it in the family Fossaridae A. Adams, 1860. Thiele (1929) considered the placement of *Conradia* uncertain, including it at the end of Fossaridae. Higo et al. (1999) transferred the genus to Skeneidae.

The description by Adams (1865) of the Japanese type of *Crossea* was not accompanied by an illustration; however, three years later, he illustrated it together with *Crossea bellula* A. Adams, 1865. A new genus name, *Crosseola* was proposed by Iredale (1924) for the Australasian species, designating as type species *Crossea concinna* Angas, 1868, from Port Jackson, New South Wales, Australia.

A. Adams (1865) originally classified *Crossea* under Epitoniidae (as Scalidae); it was classified later under Scalariidae (Watson, 1885-1886; Tryon, 1888; Tate, 1890) and Trichotropidae (May, 1922). Later, Australian and New Zealand systematists treated *Crosseola* species under Trochidae Rafinesque, 1815 (Macpherson & Gabriel, 1962); Liotiidae H. and A. Adams, 1854 (Finlay, 1927; Cotton, 1959), Cyclostrematidae Fischer, 1885 (Powell, 1961 & 1979), or Skeneidae Clark, 1851 (Beu & Maxwell, 1990; Hickman & McLean, 1990; Hickman, 1998).

Bouchet & Rocroi (2005), following the classification of Ponder (1988) and Ponder & Warén (1988), considered Conradiinae Golikov & Starobogatov, 1987 synonymous with Vanikoridae Gray, 1840, assigned in the superfamily Vanikorioidea Gray, 1840.

Hickman (2013) defined and described the family Crosseolidae, placed in the unassigned superfamily Vetigastropoda, and included the genera *Crossea* A. Adams, 1865, *Crosseola* Iredale, 1924, *Conradia* A. Adams, 1860 and *Conjectura* Finlay, 1926, previously placed in Skeneidae by W. Clark (1851). After having examining the type species of *Conradia* and *Crosseola*, Clark considered that they were similar enough to be placed in the same family. Classification at family level within Vetigastropoda is still uncertain, due to a lack of anatomical and molecular sequence data.

Bouchet et al. (2017: 75, 337, 373) considered Crosseolidae synonymous with Conradiidae Golikov & Starobogatov, 1987 (being the most recent family name), with *Conradia* as type genus and *Conradia cingulifera* A. Adams, 1860 as type species, placing it in the superfamily Trochoidea Rafinesque, 1815, based on the similarity of the radula of *Crosseola concinna* (Angas, 1868) with that of some skeneids and turbinids. Conradiidae include the same genera as Crosseolidae

Recently, Rubio & Rolán (2014, 2017a) described new Atlantic species of *Crosseola* from W. Africa, the Caribbean region and Brazil, as well as new species of *Crosseola* and *Conradia* from the Indo-Pacific.

The purpose of the present work is to complete the description of new species from the Indo-Pacific in the genera currently assigned to the family, as well as to supply new data for some previously known species. Due to the extensiveness of the work, we decided to divide it into three parts, this being the first, dedicated to the genus *Crossea*.

Material and methods

The material used for the present work was obtained during several expeditions in the Indo-Pacific organized by MNHN and IRD in the 2000s-2010s:

MUSORSTOM 6 (1989) on board R/V *Alis* on the Loyalty Ridge. (doi.org/10.17600/89004811)
MUSORSTOM 7 (1992) on board R/V *Alis* explored Wallis and Futuna. (doi.org/10.17600/92005111)
BATHUS 2 (1993) on board R/V *Alis* New Caledonia. (doi.org/10.17600/93000360)
MUSORSTOM 8 (1994) on board R/V *Alis*, explored the Vanuatu Archipelago. (doi.org/10.17600/94100040)
MUSORSTOM 10 (1998) on board R/V *Alis* explored the Fijian Archipelago. (doi.org/10.17600/98100080)
BORDAU 1 (1999) on board R/V *Alis*, explored de Fijian Archipelago. (doi.org/10.17600/99100020)
SALOMON 1 (2001) on board R/V *Alis* surveyed the central part of the Solomon Islands, from Guadalcanal to Malaita and Makira. (doi.org/10.17600/1100090)
SALOMON 2 (2004) on board R/V *Alis* explored the western part of the Solomon archipelago. doi.org/10.17600/4100090)
EBISCO (2005) (Exploration de la Biodiversité et Isolement en Mer de Corail) on board R/V *Alis* sponsored research expedition in the Coral Sea. (doi.org/10.17600/5100080)

All the material studied in the present work is constituted by empty shells, obtained in the sediments. The shells were photographed at the Scanning Electron Microscopy Center (SEM) in the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo and in the Centro de Apoyo Científico y Tecnológico of the University of Santiago de Compostela (CACTUS).

Abbreviations

CACTI: Centro de Apoyo Científico y Tecnológico a la Investigación, University of Vigo
CACTUS: Centro de Apoyo Científico y Tecnológico a la Investigación, University of Santiago de Compostela
MNHN: Muséum national d'Histoire naturelle, Paris
NMW: National Museum of Wales, Cardiff
SEM: Scanning electron microscopy
D: maximum diameter of the shell, measured perpendicular to the axis of coiling
H: total height of the shell
Stn: station
s: empty shell

SYSTEMATICS

VETIGASTROPODA Salvini-Plawen, 1980
Superfamily **TROCHOIDEA** Rafinesque, 1815
Family **CONRADIIDAE** Golikov & Starobogatov, 1987
Conradiinae Golikov & Starobogatov, 1987: 26.
Crosseolidae Hickman, 2013: 6.

Type genus: *Conradia* A. Adams, 1860

Diagnosis. Referring to the family Crosseolidae, Hickman (2013) indicated that the diagnostic characters that distinguish this family are features that are otherwise unknown in basic gastropods: the umbilical keel, the pseudo-umbilicus, the reflected anterior portion of the columellar lip, and the characteristic short, shallow anterior canal at the base of the columella. Unusual ontogenetic features occurring in the family include variciform axial thickenings on the shell, descending suture and downturned final aperture, and adult terminal variciform thickening of the outer lip.
The family Conradiidae (= Crosseolidae) currently includes the same genera: *Conradia* A. Adams, 1860; *Crossea* A. Adams, 1865; *Crosseola* Iredale, 1924 and *Conjectura* Finlay, 1926. It comprises Recent and fossil species.
The protoconch of these species is always paucispiral, which usually means small distribution areas due the difficulty of getting to distant islands with a direct embryonic development.

Habitat. Intertidal and shelf depths, microhabitat unknown, shells typically recovered from coarse to medium-fine clastic substrates, shell grit.

Distribution. The current geographic distribution of these genera is predominantly Australasia, Japan, Indo-Pacific, (*Crosseola*, *Conjectura*); South Africa and West Africa (Rubio & Rolán, 2017a, 2017b).
The geographic distribution of the genera *Crossea* and *Conradia*, includes Japan and Australasia (Rubio & Rolán, 2017b).
The distribution of the genus *Conjectura* is known in Australasia and South Africa.

Stratigraphic distribution. Eocene to Recent (Australia and New Zealand); Cretaceous (Africa). Recovered primarily by sieving bulk samples from microfossil-rich horizons.

Remarks. Although the original description of *Crossea miranda* Adams, 1865, type species of the genus, was not accompanied by any illustration, three years later A. Adams (1868: 55, pl. IV, figs 9, 10) provided the first illustrations of *Crossea miranda* and *Crossea bellula*. He noted their similarity to some *Conradia* species as for the shape and sculpture of the shell and showed that one of the most remarkable characters was the angled and channeled projection existing in the lowest part of the aperture ["Anterior canal at base of the columella" of Hickman (2013)].

Actually, the "punctate sculpture" is the main character common to the species of *Crossea*, *Crosseola* and *Conradia*. It is the ornamentation composed of spiral cords and axial ribs or marked growth lines, that, when crossed, form an irregular reticulate pattern of rectangular/quadrangular to oval spaces.

In order to make a correct generic separation of the species of this family, we present the Table I.

Table I. Identification key for the genera.

1 -	Shell turbiniform high spired	2
-	Shell turbiniform low spired	3
2 -	Early teleoconch with irregular reticulate pattern	4
3 -	Early teleoconch totally smooth	5
4 -	Umbilical cord strongly developed and crossed by numerous axial ridges	6
-	Umbilical cord scarcely developed, being formed by a periumbilical nodulose cord	***Conradia***
5 -	Umbilicus with two strong unornamented periumbilical keels	***Conjetura***
6 -	Teleoconch with variciform thickenings regularly distributed	***Crossea***
-	Teleoconch without variciform thickenings	***Crosseola***

Genus ***Crossea*** A. Adams, 1865

Crossea A. Adams, 1865: 323 [Type species: (by subsequent designation, Suter, 1913), *Crossea miranda* A. Adams, 1865. "Gotto Islands" (off western Kyushu), Japan, 64 fms].

Diagnosis (from Hickman, 2013). Adult shell size typically 4 mm. Umbilical keel strongly developed and crossed by numerous axial ridges, but not punctate. Columellar lip thinner than in *Crosseola*, with prominent anterior notch. Sculpture coarsely pitted initially, becoming cancellate and typically dominated by spiral elements on body whorl. Final lip fluted within and with exterior variciform thickening. These are irregularly placed and varying in number on shell.

Remarks. *Crossea* shares with *Crosseola* numerous characters such as:

- Sculpture coarsely initially pitted, becoming cancellate and typically dominated by spiral elements on body whorl.
- Variciform thickenings regularly placed.
- Columellar lip thinner than in *Crosseola*, with prominent anterior notch.
- Final lip fluted within and with exterior variciform thickening.
- Umbilical cord strongly developed and crossed by numerous axial ridges.
- Thick umbilical cord separated from the columellar lip by a deep pseudo-umbilical groove.
- Columellar lip thinner than in *Crosseola*, with prominent anterior notch.

The varix-like thickenings on the shell are unique to the genus. In reality, this is the true generic differentiating character.

Sasaki (2008) noted that the "varices" on shells of *Crossea miranda* are variable in their placement among individuals and are not synchronized (*sensu* Savazzi & Sasaki, 2004).

Some specimens have a double variciform thickening on the body whorl and an offset in spiral sculpture between the first and second portion of the thickening.

The coarse pitted appearance of the initial teleoconch whorl is reminiscent of the pitting in species of *Crosseola*.

Crossea and *Crosseola* have been consistently treated as closely related taxa. The Treatise on Invertebrate Paleontology treats *Crosseola* as a subgenus of *Crossea* (Knight et al. 1960).

Thiele (1929) treated *Crosseola* as a synonym of *Crossea*. *Crossea* has not been reported from fossil record and is not part of the Australasian complex of crosseolid genera and species. *Crossea* is also a relatively shallow (shelf depths) taxon that is recovered from clastic substrates.

Recent Indo Pacific species:

Crossea alliciens Melvill, 1910
Crossea biconica Hedley, 1902
Crossea cordata n. sp.
Crossea exornata n. sp.
Crossea extrema n. sp.
Crossea miranda A. Adams, 1865
Crossea nicober n. sp.
Crossea gatliffi Hedley, 1902
Crossea inverta Hedley, 1907
Crossea regularis n. sp.
Crossea sepcris n. sp.
Crossea spiralis n. sp.
Crossea ulevidens n. sp.
Crossea ultidepre n. sp.
Crossea vanuatuensis n. sp.
Crossea veraspiralis n. sp.
Crossea victori Poppe, Tagaro & Stahlschmidt, 2015

Crossea miranda A. Adams, 1865
Fig. 1A-C

Crossea miranda A. Adams, 1865: 323. Figured in A. Adams, 1868: 55-56 pl. 4 fig. 9. [Type locality: Gotto Islands, Japan, 64 fms].

Type material. Syntype MNHN-IM-2000-31223 (Fig. 1A-C).

Material examined. Gotto Islands, Japan. Collection of Journal de Conchyliologie ex Coll. Crosse & A. Adams. Examined via photograph.

Distribution. Only known from the type locality.

Habitat. Bathyal species collected at 115 m (64 fms) (A. ADAMS, 1865).

Description (based on the MNHN syntype). Shell of small size (<5.00 mm), turbinate, with a high spire formed by 4.8 whorls separated by a marked, deep suture; with axial varix and narrowly umbilicate. The protoconch is smooth and has 0.8 whorls.

The teleoconch has 4 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and variciform thickenings. When crossing each other, cords and ribs form in the interspaces an irregular reticulate pattern, composed of quadrangular /rectangular spaces in the two and a half first whorls of the teleoconch. In the last 1½ whorls, the spiral cords predominate; 2-3 prominent spiral cords angulate the periphery. There are 7 variciform axial thickenings regularly placed on the 1½ last whorl; the last one at the end of the spire on the outer lip. A prominent spiral cord formed by successive axial ridges borders and delimits the umbilicus, forming a keel. Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, arched, reflected towards the umbilicus, with an anterior channel at base. Outer lip not modified by the spiral cords; external margin thickened or variciform.

Dimensions: Syntype: 4.0 mm in diameter x 5.18 mm in height (H/D = 1.45).

Remarks. *Crossea miranda* is the type species of the genus, showing both the common generic characters and the differences, described by HICKMAN (2013: 20), which distinguish *Crossea* from *Crosseola*. The variciform thickenings on the shell constitute the true generic differential character.

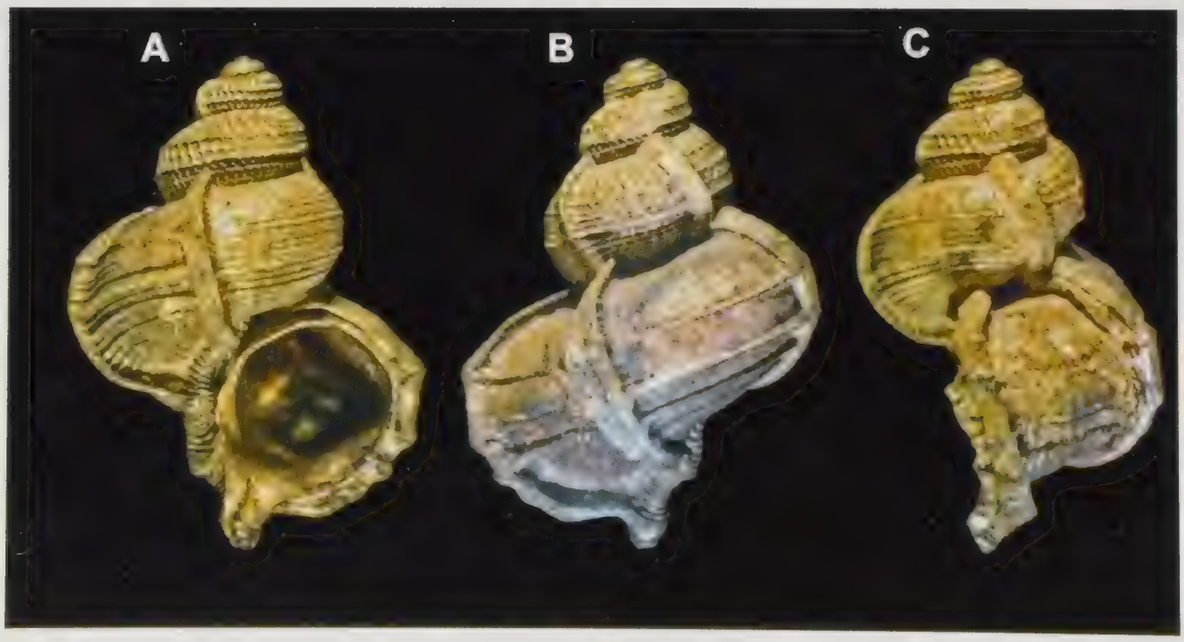

Figure 1
A-C. *Crossea miranda* A. Adams, 1865. Syntype MNHN-IM-2000-31223. Gotto Islands, Japan. Collection of *Journal de Conchyliologie* ex Coll. Crosse & A. Adams.

Crossea victori Poppe, Tagaro & Stahlschmidt, 2015
Fig. 2A-D

Crossea victori Poppe et al., 2015: 21-22, pl. 5, figs 1-2 [Type locality: Philippines, Mactan Island, Maribago].

Type material. Holotype MNHN-IM-2000-30331 (Fig. 2A-D).

Material examined. Philippines, Mactan Island, Maribago. Examined by photograph.

Description. In Poppe, Tagaro & Stahlschmidt (2015). The shell is elongate with an elevate spire, whorls convex, suture deep, in the last two whorls are present two and three axial enlargements, and one more at the spire end forms the wide outer lip. A periumbilical cord almost vertical with numerous cordlets. Umbilicus closed.

Distribution. Mactan, Olango and Jolo Islands, Philippines.

Habitat. Bathyal species collected at 130-250 m in sand and gravel bottoms (Poppe et al., 2015).

Figure 2A-D
Crossea victori Poppe, Tagaro & Stahlschmidt, 2015. Holotype MNHN-IM-2000-30331. Philippines, Mactan Island, Maribago, 3.5 mm.

Remarks. We had doubts about the assignation of this species to the genus *Crossea*, due to the lack of any clear axial ridges typical of the genus, only observed two near the end of the spire in the holotype. However, in the original description, Poppe *et al.* (2015) indicate that the shells examined develop thick varices which vary from 1-4 according to the shells viewed, mainly paratype 1 from Mactan Island.

Crossea extrema n. sp.
Fig. 3A-E

Type material. Holotype MNHN-IM-2000-34286 (Fig. 3A-B).

Material examined. New Caledonia. BATHUS 2: 1 s. stn DW730, 23°03'S-166°58'E, 397-400 m.

Type locality. S New Caledonia, 23°03'S-166°58'E, 397-400 m.

Habitat. Bathyal species dredged at 397-400 m depth.

Distribution. Only known from the type locality.

Description. Shell of very small size (<2.0 mm), robust, turbiniform, high spire formed by 3.8 whorls separated by a deep suture, carinate and narrowly umbilicated.
The protoconch has 0.8 whorls, smooth surface and a diameter of 250 µm.
The teleoconch has 3.1 whorls and its ornamentation is formed by spiral cords, axial ribs, variciform thickenings and micro-granules. The spiral peripheral cords are more prominent and one of them, as a carina, angle the periphery of the shell. The other cords are less prominent. The micro-granules cover the entire surface of the teleoconch.
In apertural view, 4 spiral cords are observed in the first and second whorls and 2 peripheral carinae and 4-5 cords in the last one. When crossing the spiral cords, the axial ribs form a regular reticle of rectangular/quadrangular spaces and small nodules at the intersection points; in the later whorl, the spiral carinae predominate. Except in the subsutural zone, all spaces between cords are markedly concave.
There are 3 variciform axial thickenings placed on the last quarter whorl; the last one is at the end of the spire on the outer lip. A prominent periumbilical cord, formed by successive thick transverse ridges, borders and delimits the umbilicus. Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella wide, thick and basally reflected towards the umbilicus, with a thick nodule and an anterior channel at the base. Outer lip with margin internally scalloped; external margin thickened or variciform.
Dimensions: Holotype: 1.74 mm in height x 1.54 mm in diameter (H/D = 1.13).

Etymology. The specific name alludes to the fact that the axial ridges (typical of the genus) only appear at the end of the spire.

Remarks. *Crossea extrema* n. sp. is characterized by thick cords and peripheral carinae; by the marked concave interspaces; by the thick periumbilical cord and by the three variciform thickenings in the last quarter of the last whorl.

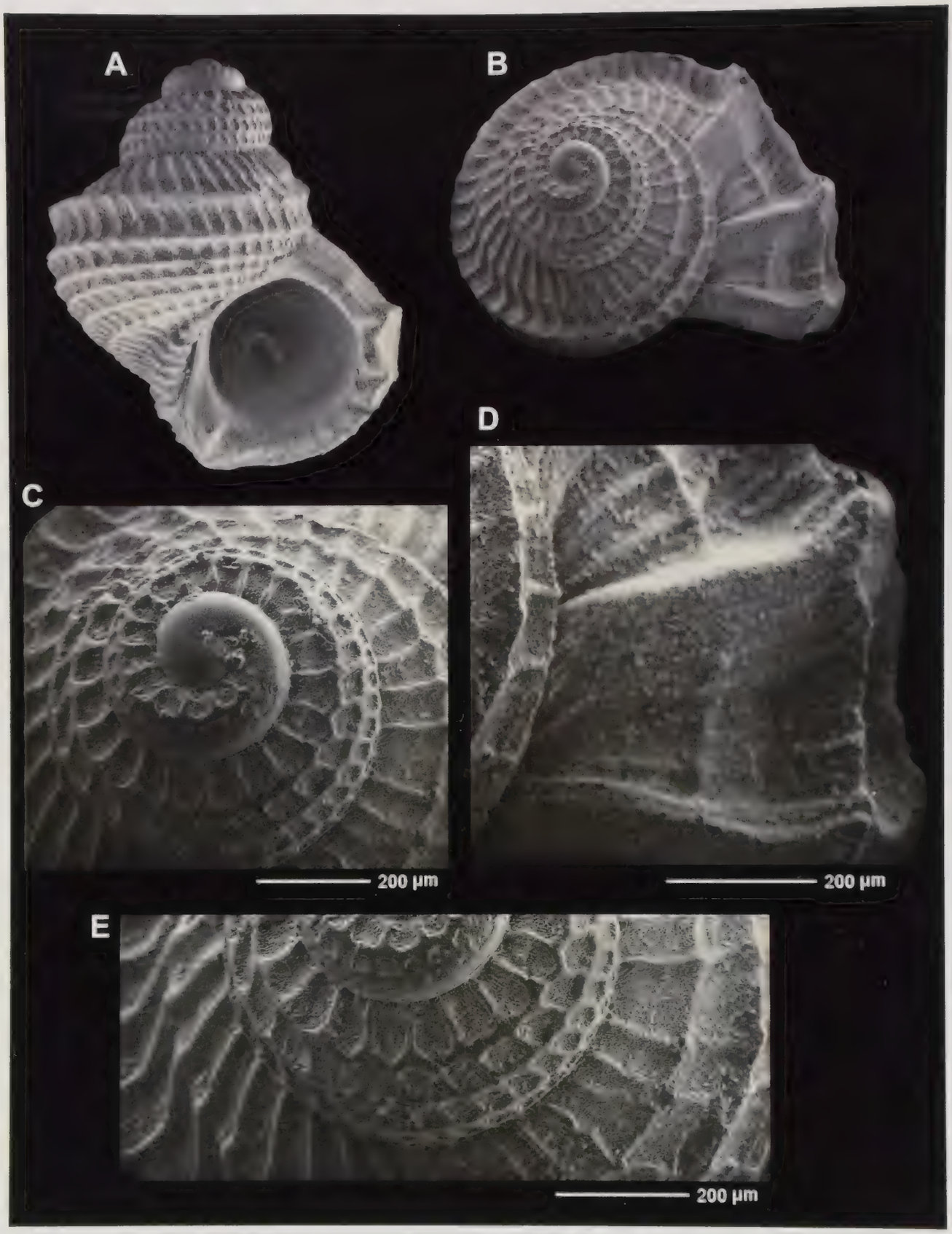

Figure 3A-E
Crossea extrema n. sp. A-B. Holotype MNHN-IM-2000-34286, 1.74 mm, S New Caledonia, 23°03'S-166°58'E, 397-400 m; C. Protoconch and first teleoconch whorls; D-E. Detail of the sculpture.

It differs from *C. ulevidens* n. sp. by its internally scalloped outer lip.
From *C. regularis* n. sp. it differs by the different distribution of the variciform thickenings.
Crossea miranda and other congeners, are distinguished by a lower spiral and the presence of three variciform thickenings in the last quarter of the last whorl.

Crossea ultidepre n. sp.
Fig. 4A-F

Type material. Holotype MNHN-IM-2000-34287 (Fig. 4A-B).

Material examined. New Caledonia, EBISCO: 1 s, NW Bellona, stn DW2565, 20°21'S-158°41'E, 414-419 m.

Type locality. New Caledonia, NW Bellona, 20°21'S-158°41'E, 414-419 m.

Habitat. Bathyal species dredged at 414-419 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<4.00 mm), turbinate, with a high spire formed by 4.8 whorls separated by a marked and deep suture; bicarinate and narrowly umbilicate.
The protoconch has 0.8 whorls, smooth surface and a size of 185 µm in diameter.
The teleoconch has 4 whorls and its periphery is bicarinate. Ornamentation formed by spiral cords and carinae, axial ribs, variciform thickenings and microgranules. The entire surface of the teleoconch is covered with microgranules. When crossing each other, cords and ribs form in the interspaces an irregular reticulate pattern, composed of quadrangular/rectangular spaces in the 2 ¾ first whorls of the teleoconch. In the last 1 ¼ whorls, the spiral cords predominate; the axial rib practically disappears, leaving only fine spiral cords and the two peripheral carinae which angle the periphery. There are 7 variciform axial thickenings regularly placed on the 1½ last whorl; the last one at the end of the spire forming the outer lip. A prominent spiral cord formed by successive axial ridges, borders and delimits the umbilicus, which is reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture ovate, prosocline; columella thin, arched, basally reflected towards the umbilicus, with an anterior channel at the base. Outer lip modified by the spiral carinae; external margin thickened or variciform.
Dimensions: Holotype: 3.06 mm in height x 2.41 mm in diameter (H/D = 0.79).

Remarks. *Crossea ultidepre* n. sp. is characterized by being peripherally bicarinate; by the almost complete disappearance in the last whorl of the axial sculpture, with the predominance of the spiral one and by the unusual shape of the periumbilical cord.
It differs from *C. extrema, C. exornata, C. cordata, C. nicober, C. veraspiralis* and *C. regularis* by not having a scalloped internally outer lip.

Etymology. The specific name alludes to the shell sculpture, which in the last whorl is very depressed, by the fusion of the Latin adjectives *ultimus, a, um*, "ulti" and *depressus, a, um* "depre".

Crossea ulevidens n. sp.
Fig. 5A-D

Type material. Holotype MNHN-IM-2000-34288 (Fig. 5A-B).

Material examined. New Caledonia, MUSORSTOM 6: 1 s, Lifou, 20°42'S-167°00'E, stn DW416, 343 m.

Type locality. New Caledonia, Lifou, 20°42'S-167°00'E, stn DW416, 343 m.

Habitat. Bathyal species dredged at 343 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<3.0 mm), robust, turbiniform, with a high spire formed by 4.8 whorls separated by a deep suture, carinate and narrowly umbilicate.
The protoconch is broken.
The teleoconch has 4 whorls and its ornamentation is formed by spiral cords, axial ribs, variciform thickenings and microgranules. The peripheral cords are the most prominent and as carinae they angle slightly at the periphery.
In apertural view, 4 spiral cords are observed in the first and second whorls and 2 peripheral carinae and 12 cords on the last whorl. The axial ribs, when crossing the spiral cords, form a regular reticle of rectangular/quadrangular spaces and small nodules at intersection points. Except in the subsutural zone, all spaces between cords are markedly concave. The microgranules cover the entire surface of the teleoconch.
There are 2 variciform axial thickenings located at the middle of the last whorl; the last one is placed at the end of the spire on the outer lip. A prominent periumbilical cord formed by successive transverse ridges borders and delimits the umbilicus. Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella wide, thick and basally reflected towards the umbilicus, with an anterior channel at base. Outer lip with external margin thickened or variciform and inner margin not scalloped.

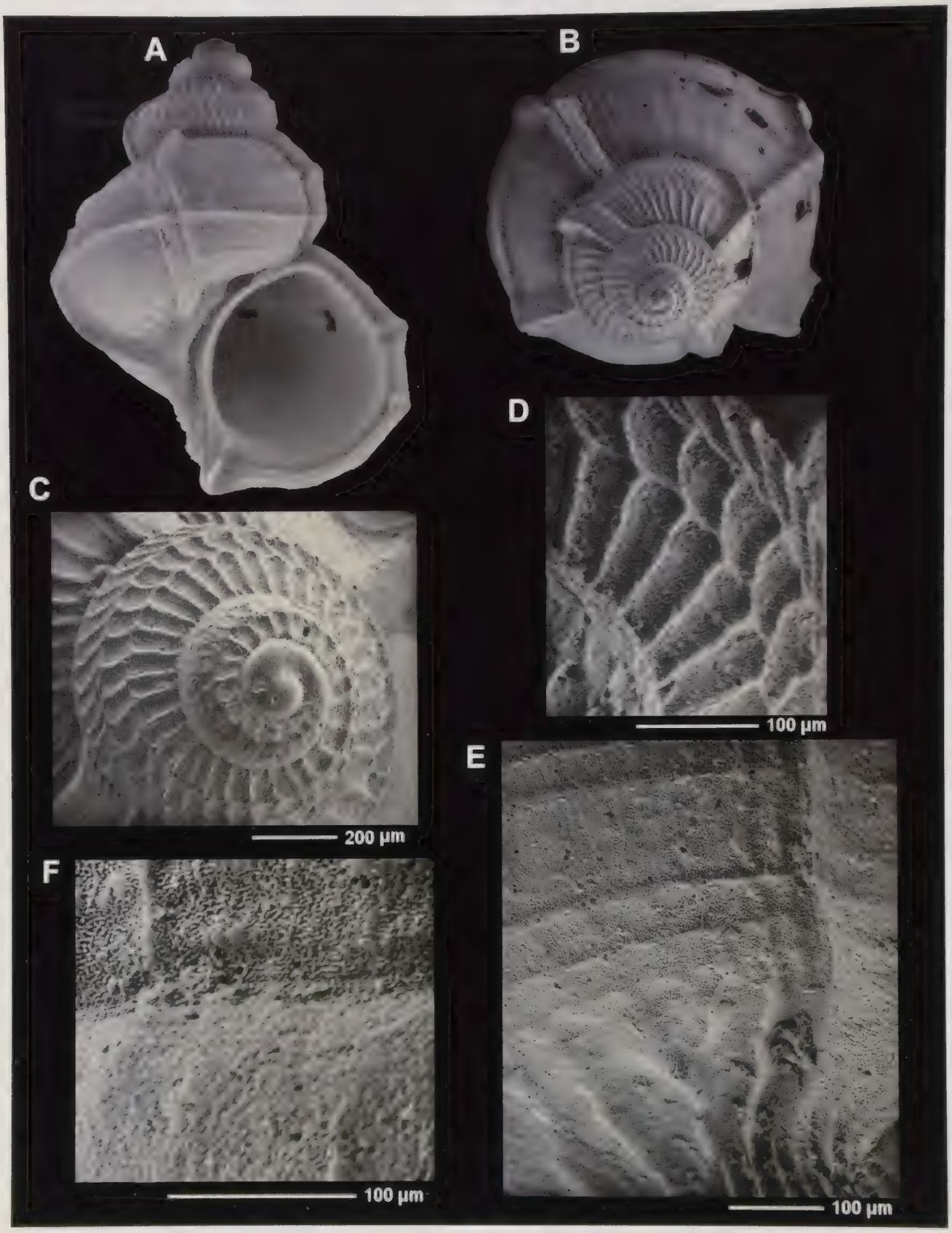

Figure 4A-F
Crossea ultidepre n. sp. A-B. Holotype MNHN-IM-2000-34287, 3.06 mm, New Caledonia, NW Bellona, 20°21'S-158°41'E, 414-419 m; C. Protoconch and first teleoconch whorls; D-F. Detail of the sculpture and microsculpture.

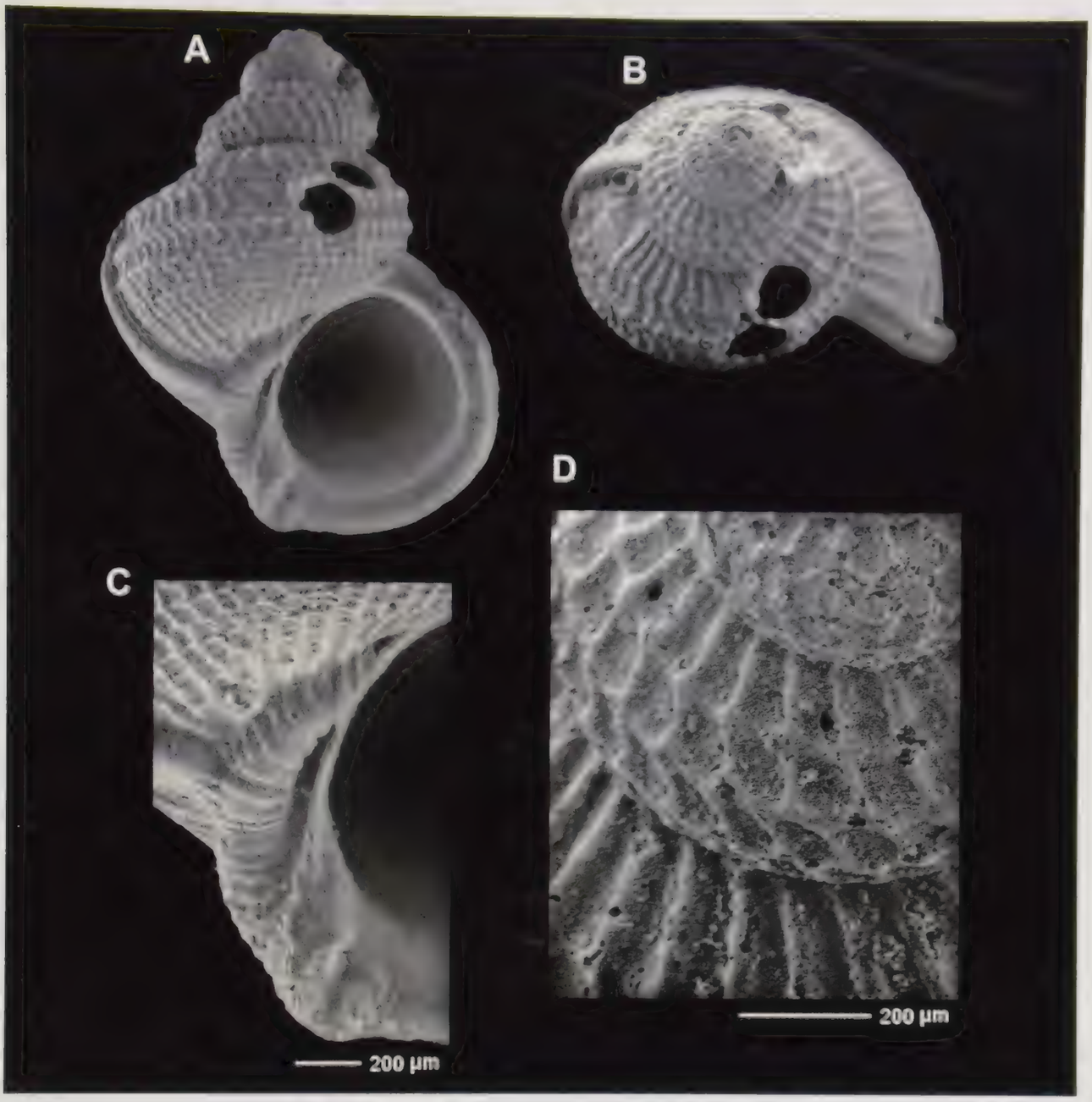

Figure 5A-D
Crossea ulevidens n. sp. A-B. Holotype MNHN-IM-2000-34288, 2.6 mm, New Caledonia, NW Lifou, 20°42'S-167°00'E, 343 m; C-D. Detail of the sculpture.

Dimensions: Holotype: 2.6 mm in height x 2.11 mm in diameter (H/D = 1.23).

Remarks. Despite disposing of only a single specimen, which moreover is in a poor condition, we have decided to describe it and give it a name because its characters do not resemble those of any other known species and can be clearly distinguished.
Crossea extrema n. sp. has a similar aspect, but the number of spiral cords is lower (about 7 in the last whorl in front compared to about 15-17 in *C. ulevidens* n. sp.).
The new species differs from *C. regularis* by the larger number of spiral cords. It differs from *C. extrema* by the different distribution of variciform thickenings. It differs also from *C. exornata, C. cordata, C. nicober, C. veraspiralis* and *C. regularis* by the absence of an internally scalloped outer lip.

Etymology. The specific name alludes to its sculpture, which in the last whorl is evident, with the fusion of the beginning of the Latin words *ultimus, a, um* "ul", and *evidens, entis* "evidens".

Crossea exornata n. sp.
Fig. 6A-G

Type material. Holotype MNHN-IM-2000-34289 (Fig. 6A-B).

Material examined. New Caledonia, MUSORSTOM 6: 1 s, stn DW459, Lifou, E Cap des Pins 21°01'S-167°31'E, 425 m.

Type locality. New Caledonia, Lifou, E Cap des Pins 21°01'S-167°31'E, 425 m.

Habitat. Bathyal species dredged at 425 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<4.00 mm), turbinate, with a high spire formed by 5 whorls separated by a marked and deep suture, not carinate and narrowly umbilicate.
The protoconch has 0.8 whorls, a smooth surface and a size of 230 µm in diameter.
The teleoconch has 4.2 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs, variciform thickenings and microgranules. The entire surface of the teleoconch is covered by microgranules. Cords and ribs cover the entire surface of the teleoconch, forming in the interspaces an irregular reticle of rectangular/quadrangular spaces and a small nodule at intersection point.
There is no predominance of axial or spiral ornamentation; only 2-3 peripheral cords that project slightly over the others, but without affecting the rounded periphery of the teleoconch. The variciform axial thickenings are very wide and prominent; there are 3 variciform axial thickenings regularly placed on the last whorl; the last one is at the end of the spire on the outer lip. A prominent periumbilical cord formed by successive axial ridges borders and delimits the umbilicus.
Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, arched, basally reflected towards the umbilicus, with an anterior channel at the base. Outer lip scalloped internally with external margin thickened or variciform.
Dimensions: Holotype: 3.55 mm in height x 2.67 mm in diameter (H/D = 1.33).

Remarks. *Crossea exornata* n. sp. is characterized by the number and size of the very prominent variciform axial thickenings; because there is no predominance of one ornamentation over the other; by the shape of the periumbilical cord; and by the outer lip internally scalloped. *Crossea ulevidens* n. sp. can have some of the above characters, but its periumbilical cord is wider, its apertural outer lip is not modified by the spiral sculpture, and the microsculpture is not so fine. Also the axial ridges appear more separate.
Crossea exornata n. sp. differs also from *C. ultidepre, C. sepcris, C. vanuatuensis* and *C. spiralis* by having an internally scalloped outer lip.

Etymology. The specific name alludes to the fact that the shell is entirely covered by a prominent sculpture, employing the participle of the Latin verb *exorno, as, are, avi, atum* which means "to adorn, to embellish".

Crossea sepcris n. sp.
Fig. 7A-E

Type material. Holotype MNHN-IM-2000-34290.

Material examined. New Caledonia, EBISCO: 1 s, Lansdowne, stn DW2617, 20°06'S-160°22'E, 427-505 m.

Type locality. New Caledonia, Lansdowne, 20°06'S-160°22'E, 427-505 m.

Habitat. Bathyal species dredged at 427-505 m depth.

Distribution. Only known from the type locality.

Description. Shell of very small size (<2.0 mm), robust, turbiniform, with a high spire formed by 4 whorls separated by a deep suture, carinate and narrowly umbilicate.
The protoconch has 0.75 whorls, smooth surface and size 227 µm in diameter.
The teleoconch has 3.25 whorls. The ornamentation is formed by spiral cords, some more prominent as a carina that angulates the periphery of the shell; there are also ribs, axial varices and microgranules. In apertural view, there are 5 spiral cords on the first and second whorls, 2 peripheral carinae and 8-9 thinner cords on the last one. Axial ribs cross the spiral cords forming nodules at the intersection points. In the first two whorls, the ribs crossing spiral cords form a regular lattice of square or rectangular spaces; in the later whorls the spiral carinae predominate and the axial ribs also form rectangular spaces. In the last two whorls there are 7 variciform axial thickenings placed on the last 1½ whorls; the last one is at the end of the spire on the outer lip. A prominent periumbilical cord formed by successive fine axial ridges borders and delimits the umbilicus, forming a keel. Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, straight and reflected towards the umbilicus, with an earlier channel at the base. Outer lip with scalloped margin, modified by the spiral carinae; external margin thickened or variciform.
Dimensions: Holotype: 1.92 mm in height x 1.65 mm in diameter (H/D = 1.16).

Remarks. *Crossea sepcris* n. sp. is characterized by the numerous axial ridges (7 on the last whorl), a very fine microsculpture of tubercles, and the presence of two main carinae and several spiral cords on the last 1½ whorls.

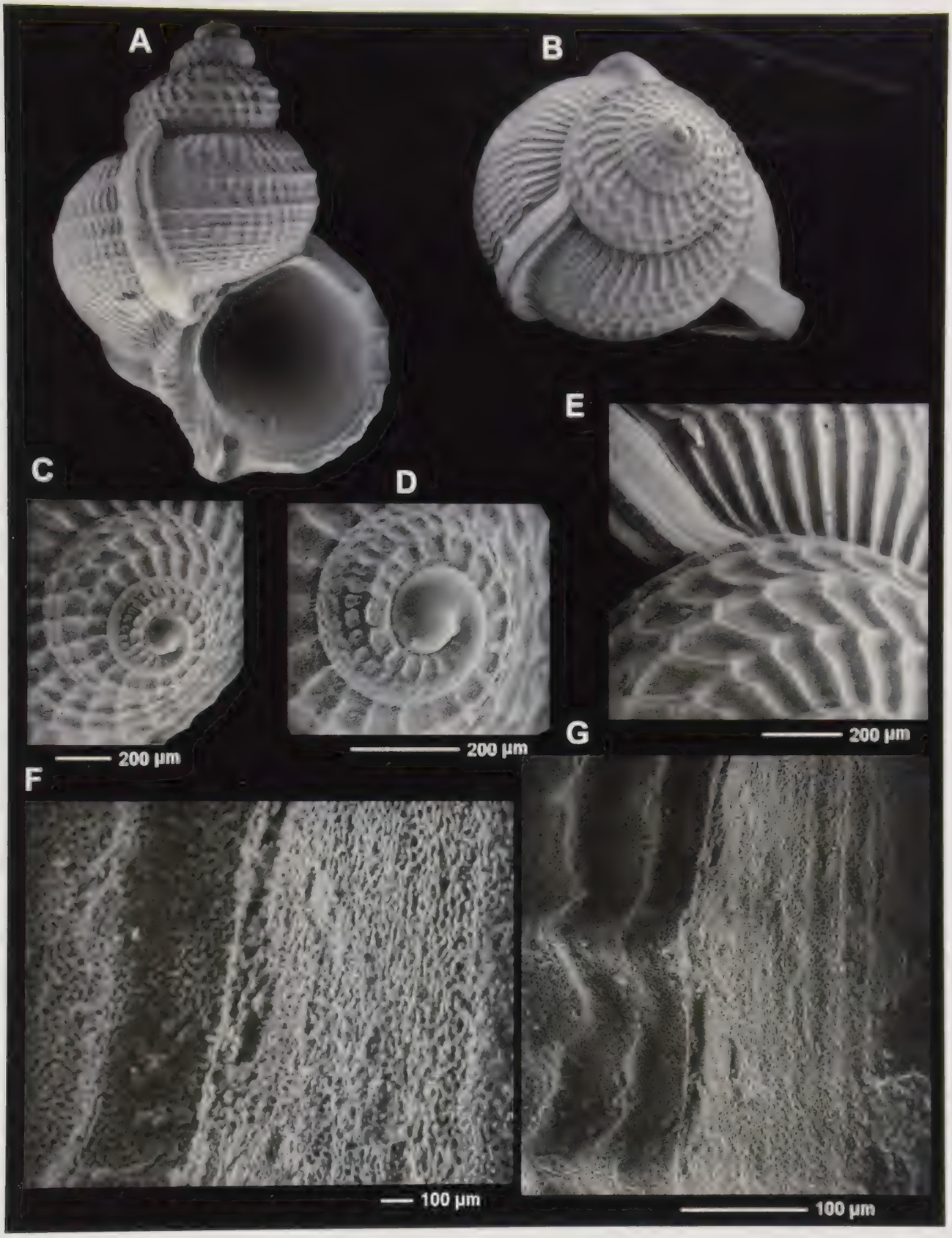

Figure 6A-G
Crossea exornata n. sp. A-B. Holotype MNHN-IM-2000-34289, 3.55 mm in height, New Caledonia, Lifou, E Cap des Pins, 21°01'S-167°31'E, 425 m; C-D. Protoconch and first teleoconch whorls; E-G. Sculpture and microsculpture.

Crossea ultidepre n. sp. from New Caledonia has one less spiral carina, and the microsculpture of the last whorl is more depressed and less apparent; it also has fewer axial ridges.

Crossea exornata n. sp. from New Caledonia has a larger shell, more elongate, with the main spiral carinae smaller and which do not cross the axial ridges. It differs also from *C. extrema, C. cordata, C. nicober, C. veraspiralis* and *C. regularis* by not having an internally scalloped outer lip.

Etymology. The specific name is formed by the union of the beginning of the Latin words *septem* which means "seven" and *crista* "crest", alluding to the presence of the seven axial elevations on the last whorl.

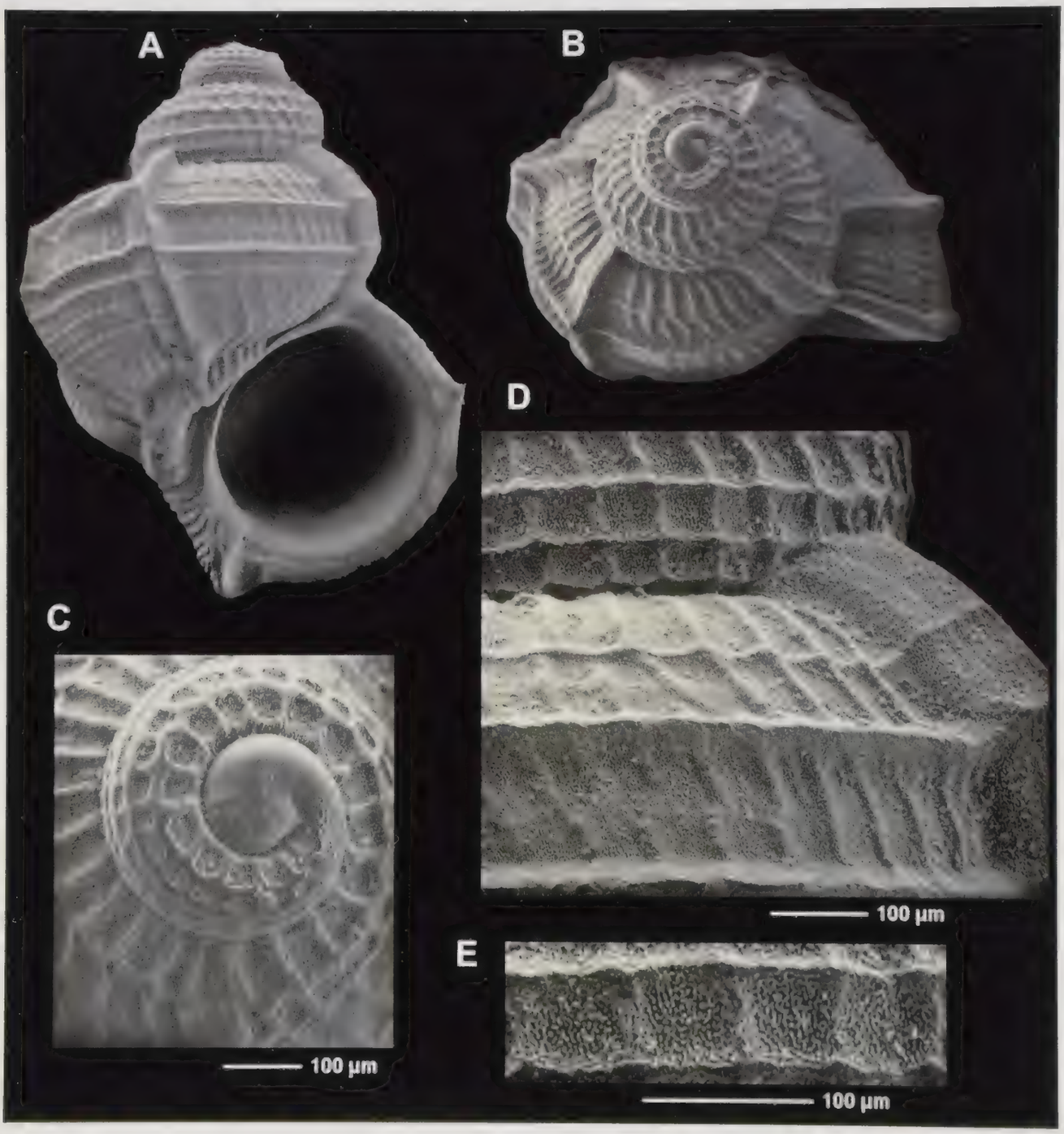

Figure 7A-E
Crossea sepcris n. sp. A-B. Holotype MNHN-IM-2000-34290, 1.92 mm in height, New Caledonia, Lansdowne, 20°06'S-160°22'E, 427-505 m; C. Protoconch; D-E. Sculpture and detail.

Crossea cordata n. sp.
Fig. 8A-D

Type material. Holotype MNHN-IM-2000-34292 (Fig. 8A-B) and one paratype MNHN-IM-2000-34293.

Material examined. Wallis & Futuna, MUSORSTOM 7: 2 s, stn DW601, 13°19'S-176°17'W, 350 m.

Type locality. Wallis & Futuna, Wallis Island, 13°19'S-176°17'W, 350 m.

Habitat. Bathyal species dredged at 350 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<5.0 mm), robust, turbiniform, high spire formed by 5.3 whorls separated by a deep suture, carinate and narrowly umbilicate.
The protoconch has 0.8 whorls, smooth surface and a size of 280 µm in diameter.
The teleoconch has 4.5 whorls. The ornamentation is formed by prominent spiral cords, as a carina that angulates the periphery of the shell; between them there are intermediate spiral cordlets, ribs and axial varices. In apertural view there are 3 spiral cords in the first whorl, 2 peripheral carinae and 2 cordlets in the second and third whorls, and a subsutural cord and 6 peripheral carinae on the last one. Axial ribs cross the spiral cords forming nodules at the intersection points. In the first two whorls, the axial ribs crossing the spiral cords form a regular lattice of square or rectangular spaces; in the later whorls the spiral carinae predominate and the axial ribs form rectangular spaces between them.
In the last two whorls, there are 7 variciform axial thickenings; the last of them is at the end of the spire on the outer lip. A prominent periumbilical cord formed by successive fine axial ridges borders and delimits the umbilicus, forming a keel. Umbilicus is reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, straight, reflected towards the umbilicus, with an anterior channel at the base. Outer lip with margin scalloped, modified by the spiral carinae; external margin thickened or variciform.
Dimensions: Holotype: 4.4 mm in height x 3.14 mm in diameter (H/D = 1.35). Paratype is 3.26 mm in diameter.

Remarks. Differential characters in *Crossea cordata* n. sp. are the presence of six prominent carinae on the last whorl, but with their presence in lower number in the previous whorls. The axial sculpture is orthocline.
Crossea sepcris n. sp. from New Caledonia has a shell with a smaller height, the prominent carinae are only two, spirally with several cords, the axial sculpture is prosocline, and the number of the axial ridges is higher.

Etymology. The specific name alludes to the presence of numerous spiral elevated cords, unusual in other species of this genus.

Crossea nicober n. sp.
Fig. 9A-E

Type material. Holotype MNHN-IM-2000-34294 (Fig. 9A) and 1 paratype MNHN-IM-2000-34295 (Fig. 9B).

Material examined. Fiji, MUSORSTOM 10: 1 s, S Viti Levu, stn DW1383, 18°18'S-178°03'E, 230-251 m (holotype); 1 s, S Viti Levu, stn DW1376, 18°19'S-178°09'E, 497-504 m (paratype).

Type locality. Fiji, S Viti Levu, 18°18'S-178°03'E, 230-251 m.

Habitat. Bathyal species dredged at 230-504 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<5.0 mm), robust, turbiniform, with a high spire formed by 5¼ whorls separated by a deep suture, carinate and narrowly umbilicate.
The protoconch has 0.75 whorls, with a smooth surface and a size of 232 µm in diameter. The teleoconch has 4½ whorls. The ornamentation is formed by prominent spiral cords, like carinae which angle the periphery of the shell; there are spiral intermediate cordlets and also axial ribs and varices. In apertural view, 4 spiral cords are seen in the first whorl, 2 peripheral carinae and 2 cordlets on the second and third whorls, and a subsutural cord and 5 peripheral carinae in the last one. The axial ribs cross the spiral cords forming small nodules at the intersection points. On the first two whorls, the axial ribs when crossing the spiral cords form a regular reticle of rectangular/quadrangular spaces. In the later whorls the ribs become thinner and more numerous, narrowing the spaces. The last two whorls have 7 variciform axial thickenings, grouped by two or three; the last three are placed at the end of the spire on the outer lip. A prominent periumbilical cord, formed by successive fine axial ridges borders and delimits the umbilicus, forming a keel. Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline. Columella thin, straight, reflected towards the umbilicus, with an earlier channel at the base. Outer lip with a scalloped margin, modified by the spiral carinae; external margin thickened or variciform.

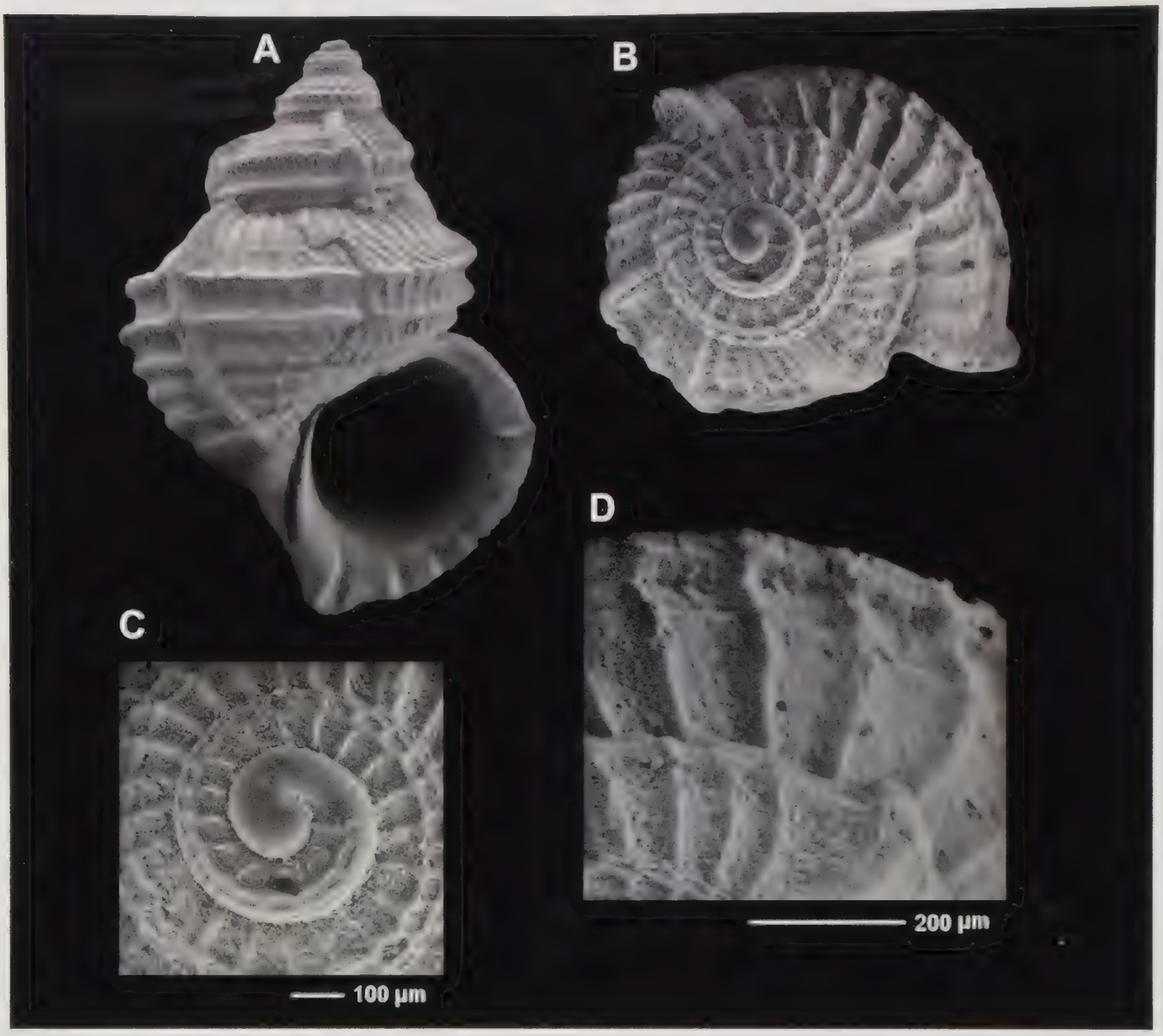

Figure 8A-D
Crossea cordata n. sp. A-B. Holotype MNHN-IM-2000-34292, 4.4 mm, Wallis & Futuna, Wallis Island, 13°19'S-176°17'W, 350 m; C. Protoconch; D. Sculpture.

Dimensions: Holotype: 4.70 mm in height x 3.56 mm in diameter (H/D = 1.32); the paratype is 3.70 mm in diameter.

Remarks. *Crossea nicober* n. sp. from Fiji is characterized by the prominent carinae that angulate the periphery of the shell; by thin and very numerous axial riblets forming small nodules at the intersections with the spiral cords. By the variciform thickenings that are grouped in two or three in the last 1½ whorls and by its outer lip which has a scalloped margin.
It differs from *C. miranda*, type species of the genus, by the increased number and size of the carinae and by its axial ornamentation, formed by fine and very numerous axial ribs.
Crossea cordata n. sp. from Wallis is distinguished by the higher number of spiral carinae in the last whorl and because the axial varices are regular and not grouped by two or three as in *Crossea nicober* n. sp.

Etymology. The specific name is formed by the union of the beginning of two names: Nicolás Francolini, called "Nico" and Bernardo Medina, called "Ber" and good friends of the first author. Noun in apposition.

Crossea spiralis n. sp.
Fig. 10A-D

Type material. Holotype MNHN-IM-2000-34296 (Fig. 10A-B).

Material examined. Fiji, BORDAU 1: 1 s, Lau Ridge, stn DW1469, 19°40'S-178°10'W, 314-377 m.

Type locality. Fiji, Lau Ridge, 19°40'S-178°10'W, 314-377 m.

Habitat. Bathyal species dredged at 314-377 m depth.

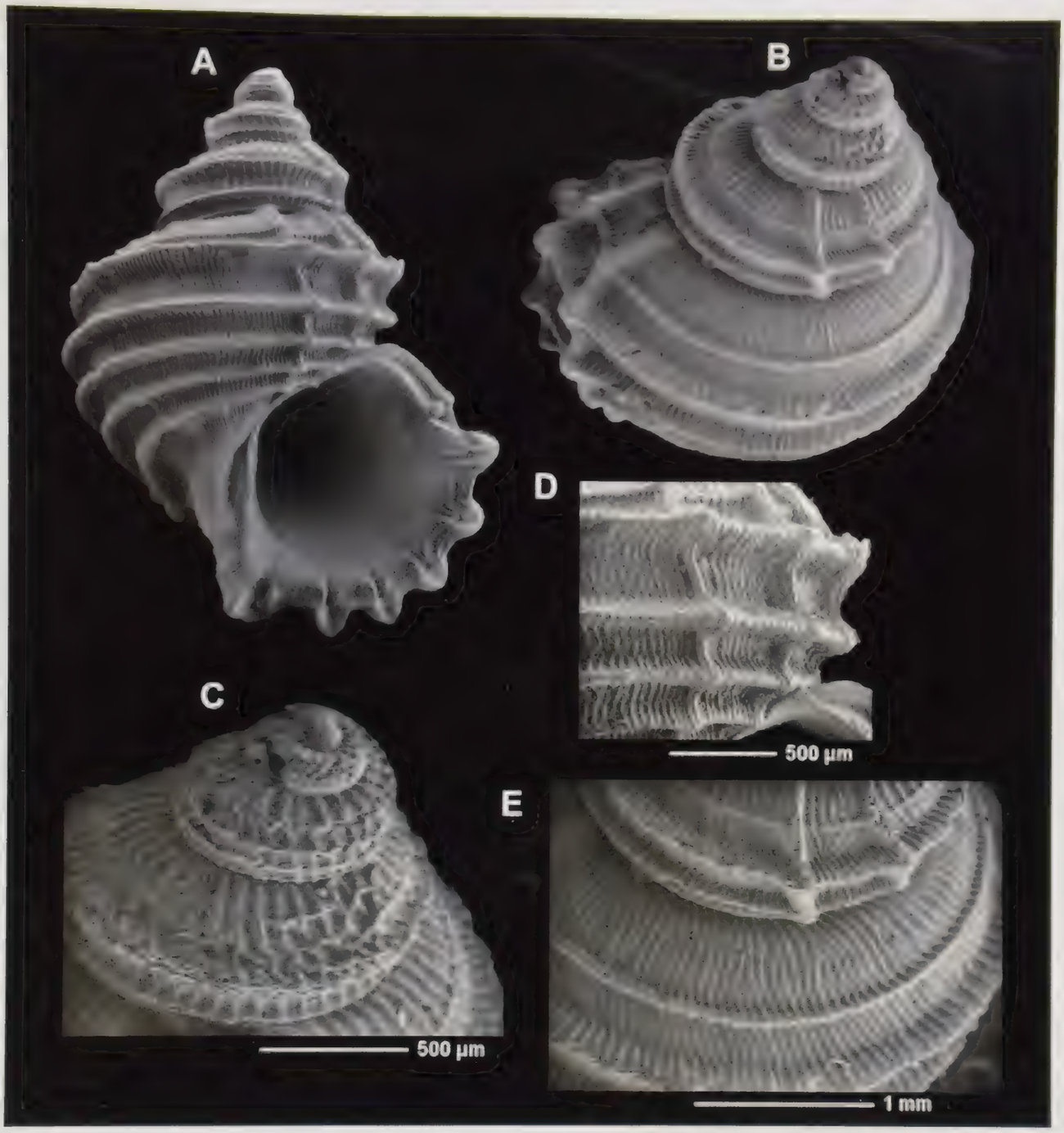

Figure 9A-E
Crossea nicober n. sp. A. Holotype MNHN-IM-2000-34294, 4.7 mm in height, Fiji, S Viti Levu, 18°18'S-178°03'E, 230-251 m; B. Paratype MNHN-IM-2000-34295, 3.7 mm in diameter, same locality, 497-504 m; C. Protoconch and first teleoconch whorls; D-E. Sculpture.

Distribution. Only known from the type locality.

Description. Shell of small size (<4.5 mm), turbinate, with a high spire formed by 4.3 whorls separated by a marked and deep suture; not carinated and narrowly umbilicate.
The protoconch is damaged.
The teleoconch has 3.5 whorls and its periphery is rounded, non carinate. Ornamentation formed by spiral cords, axial ribs, variciform thickenings and microgranules. The entire surface of the teleoconch is covered by microgranules. Cords and ribs cover the entire surface of the teleoconch, in the first two whorls forming a regular reticle of rectangular/quadrangular spaces and small nodules at intersection points. In the last 1½ whorls, the spiral cords predominate; the axial ribbing practically disappears, leaving only fine spiral cords; in apertural view 4-5 spiral cords are seen in the first whorl, 5-6 in the second and 22-24 in the last. There are 6 variciform axial thickenings regularly placed on the 1½ whorls on the last part of the shell; the last one is at the end of the spire on the outer lip;

Figure 10A-D
Crossea spiralis n. sp. A-B. Holotype MNHN-IM-2000-34296, 4.28 in height, Fiji, Lau Ridge, 19°40'S-178°10'W, 314-377 m; C-D. Detail of the sculpture.

its anterior side is smooth and the posterior side is covered by spiral cords.
A prominent periumbilical cord formed by successive axial lamellae borders and delimits the umbilicus.
Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip.
Aperture ovate, prosocline; columella thin, arched, basally reflected towards the umbilicus, with an anterior channel at the base. Outer lip not modified by the spiral cords; external margin thickened or variciform.
Dimensions: Holotype: 4.00 mm in height x 2.96 mm in diameter (H/D = 0.74).

Remarks. *Crossea spiralis* n. sp. is characterized by its rounded periphery; by the predominance of the spiral sculpture in the last 1½ whorls and by the number and ornamentation of the variciform thickenings.
The most similar species at first glance is *Crossea ultidepre* n. sp. from New Caledonia, but the latter has a slightly smaller shell, with two prominent spiral cords; the sculpture is very depressed in both species but in *C. ultidepre* n. sp. that spiral is only present on the lower part of the last whorl, below the cords, while in *C. spiralis* it is present on the entire last whorl.

Figure 11A-D
Crossea vanuatuensis n. sp. A-B. Holotype MNHN-IM-2000-34297, 2.64 mm in height, Vanuatu, 20°19'S-169°53'E, 252-280 m; C. Protoconch; D. Sculpture.

Etymology. The specific name alludes to the predominant microsculpture that is spiral, although depressed on the last whorl.

Crossea vanuatuensis n. sp.
Fig. 11A-D

Type material. Holotype MNHN-IM-2000-34297 (Fig. 11A-B).

Material examined. Vanuatu, MUSORSTOM 8: 1 s, stn DW969, 20°19'S-169°53'E, 252-280 m.

Type locality. Vanuatu, 20°19'S-169°53'E, 252-280 m.

Habitat. Bathyal species dredged at 252-280 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<3.0 mm), turbinate, with a high spire formed by 4.3 whorls separated by a marked and deep suture; not carinate and narrowly umbilicate.
The protoconch has 0.8 whorls, smooth surface and a size of 238 µm in diameter.
The teleoconch has 3.5 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs, variciform thickenings and microgranules. The entire surface of the teleoconch is covered by microgranules; and cords and ribs are present on the entire surface of the teleoconch, forming a regular reticle of rectangular/quadrangular spaces and small nodules formed at intersection points.

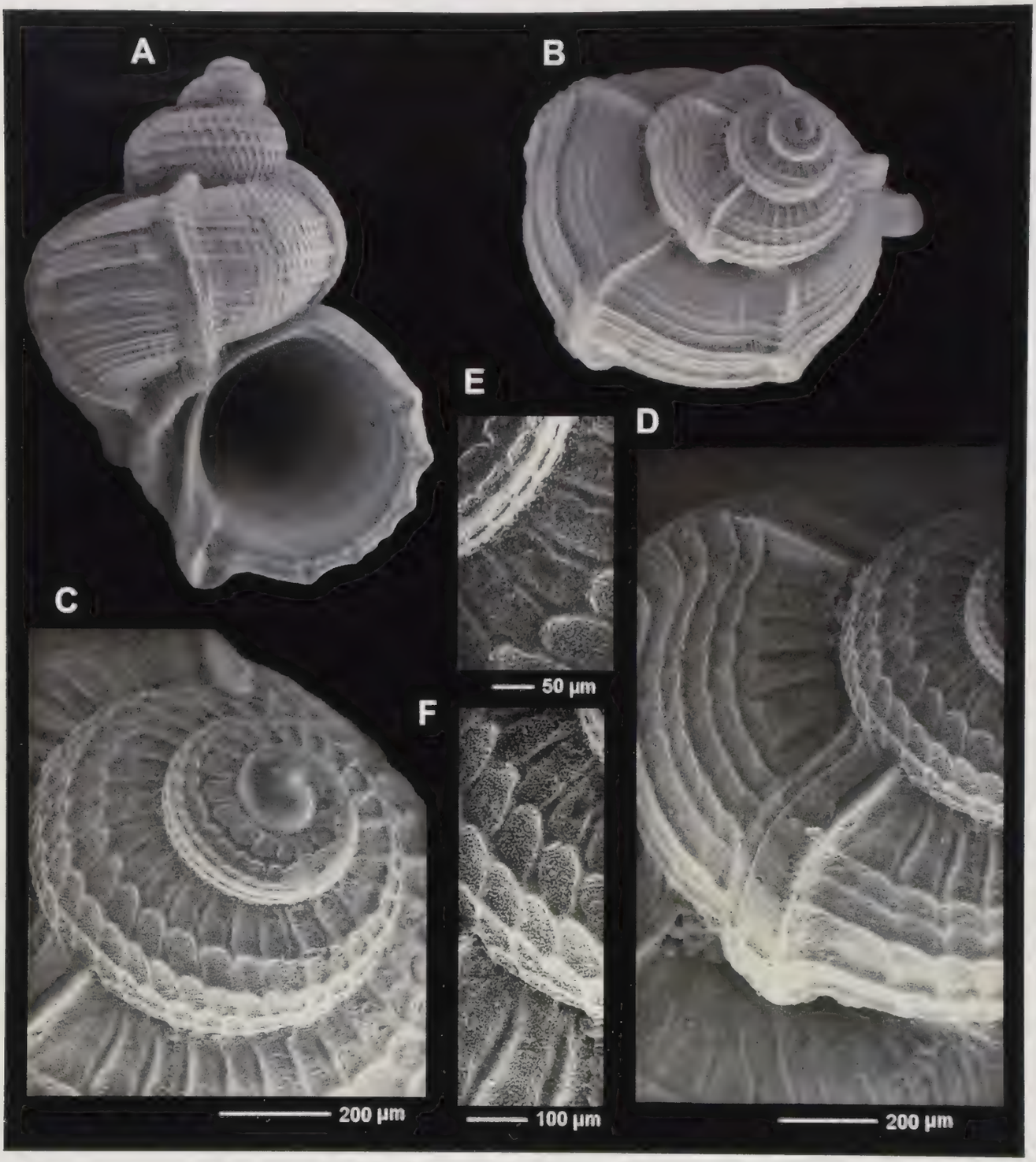

Figure 12A-F
Crossea veraspiralis n. sp. A-B. Holotype MNHN-IM-2000-34298, 3.28 mm in height, Solomon Islands, SE Sta Isabel Island, 08°17'S-160°00' E, 489-491 m; C. Protoconch and first teleoconch whorls; D-F. Sculpture and microsculpture.

There is no predominance of axial or spiral ornamentation; only the peripheral cords that project slightly over the others, but they do not modify the rounded periphery of the teleoconch. The variciform axial thickenings are very wide and prominent, and they are crossed by spiral cords; there are 6 variciform axial thickenings regularly placed on the last two whorls; the last of them, at the end of the spire on the outer lip.

A prominent periumbilical cord is formed by successive strong axial ridges, borders and delimits the umbilicus.

Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip.

Aperture rounded, prosocline; columella thin, arched, basally reflected towards the umbilicus, with an anterior channel at the base. Outer lip scalloped internally with external margin thickened or variciform.
Dimensions: Holotype: 2.62 mm in height x 1.89 mm in diameter (H/D = 0.72).

Remarks. *Crossea vanuatuensis* n. sp. is characterized by the regularity of its reticulation; by its non-carinated periphery; by the axial lamellae of the periumbilical cord, thicker and less numerous than in its congeners and because the spiral cords, unlike other species, cross the variciform axial thickenings.
It differs from *Crossea veraspiralis* n. sp. by the regularity of its reticulation; by the lower number of axial lamellae in the periumbilical cord and by the lack of axial lines in the variciform thickenings. From *C. sepcris* n. sp. it differs by its high spire.

Etymology. The specific name alludes to the archipelago where the species was collected.

Crossea veraspiralis n. sp.
Fig. 12A-F

Type material. Holotype MNHN-IM-2000-34298 (Fig. 12A-B).

Material examined. Solomon Is. SALOMON 2: 1 s, stn DW2183, SE Santa Isabel Island, 08°17'S-160°00'E, 489-491 m.

Type locality. Solomon Islands, SE Santa Isabel Island, 08°17'S-160°00'E, 489-491 m.

Habitat. Bathyal species dredged at 489-491 m depth.

Distribution. Only known from the type locality.

Description. Shell of small size (<4.0 mm), turbinate, with a high spire formed by 4.8 whorls separated by a marked and deep suture; not carinate and narrowly umbilicate.
The protoconch has 0.8 whorls, a smooth surface and a size of 232 µm in diameter.
The teleoconch has 4 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs, variciform thickenings and microgranules. The entire surface of the teleoconch is covered by microgranules. Cords and ribs cover the entire surface of the teleoconch, forming an irregular reticle of rectangular/quadrangular spaces in the interspaces and small nodules at intersection points.
There is a predominance of spiral ornamentation, especially on the last whorl; only some peripheral cords project slightly over the others, but without altering the rounded periphery of the teleoconch.
The 9 variciform axial thickenings are very wide and prominent and they have numerous axial growth lines regularly placed on the two last whorls; the last one at the end of the spire on the outer lip. A prominent periumbilical cord is formed by successive axial lamellae, and it borders and delimits the umbilicus.
Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip.
Aperture rounded, prosocline; columella thin, arched and basally reflected towards the umbilicus, with an anterior channel at base. Outer lip scalloped internally with external margin thickened or variciform.
Dimensions: Holotype: 3.43 mm in height x 2.74 mm in diameter (H/D = 1.19).

Remarks. *Crossea veraspiralis* n. sp. has as differential characters the number of spiral cords on the last whorl; by the greater number of axial lamellae on its periumbilical cord; by the presence of axial growth lines in the variciform thickenings; and by its internally scalloped outer lip.
It differs from *Crossea regularis* n. sp. (see below) by being smaller; by the greater number of spiral cords on its last whorl; by the irregular reticulation; and by the outer lip being scalloped internally.
Crossea vanatuensis n. sp. is slightly smaller, has fewer axial ridges on the last whorl, the sculpture of the periumbilical cord is vertical and the peripheral sculpture is formed of rectangles.
Crossea spiralis n. sp. from Fiji has a shell with more attenuated peripheral sculpture, mainly the axial one, the outer lip has smaller prominences.
Crossea exornata n. sp. from New Caledonia, has fewer axial ridges which are stronger and lack microsculpture, the peripheral sculpture (especially the axial one) is more prominent, the outer lip has less prominent nodules.
Crossea ulevidens n. sp. is smaller, with more prominent sculpture, but the axial ridges are few and not very prominent, the periumbilical cord is wider.

Etymology. The specific name derives from the Latin words *vera* which means "really" and *spiralis* alluding to the sculpture which is more evident than in the species called *C. spiralis* n. sp.

Crossea regularis n. sp.
Fig. 13A-F

Type material. Holotype MNHN-IM-2000-34299 (Fig. 13A-B).

Material examined: Solomon Islands, SALOMON 1: 1 s, stn DW1762, 08°40'S-160°04'E, 396-411 m.

Type locality. Solomon Islands, 08°40'S-160°04'E, 396-411 m.

Habitat. Bathyal species dredged at 396-411 m depth.

Distribution. Only known from the type locality.

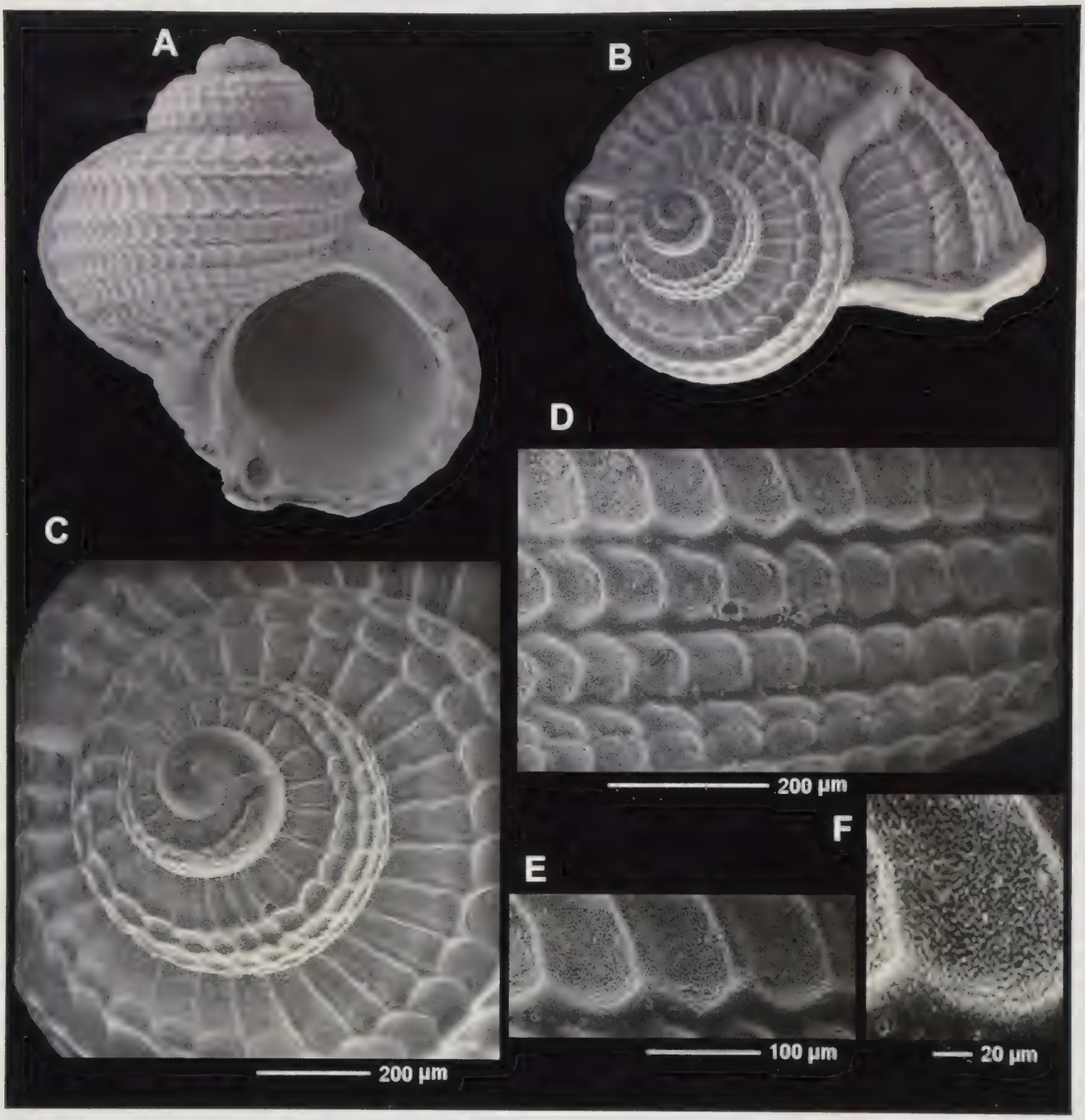

Figure 13A-F
Crossea regularis n. sp. A-B. Holotype MNHN-IM-2000-34299, 1.82 mm, Solomon Islands, 08°40'S-160°04'E, 396-411 m; C. Protoconch and first teleoconch whorls; D-F. Sculpture and details.

Description. Shell of very small size (<2.0 mm), robust, globose to turbinate, almost as high as wide, formed by 3.8 whorls separated by a marked suture, non carinated and narrowly umbilicated.
The protoconch is smooth, has about 0.8 whorls with a maximum diameter of 227 µm. The teleoconch has 3.1 whorls and its periphery is rounded.
Ornamentation formed by spiral cords, axial ribs, variciform thickenings and microgranules; the spaces between cords are not convex. The entire surface of the teleoconch is covered by microgranules. Cords and ribs cover the entire surface of the teleoconch, forming a regular reticle of rectangular/quadrangular spaces and small not very prominent nodules at intersection points.
In apertural view, 4 spiral cords are visible on the first two whorls, and 7 on the last one.
The variciform axial thickenings are very wide and prominent; there are 3 variciform axial thickenings regularly placed on the half last whorl; the last one at the end of the spire on the outer lip.
A prominent periumbilical cord is formed by successive strong transverse ribs, and it borders and delimits the umbilicus.
Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip.

Aperture rounded, prosocline; columella thin, arched and basally reflected towards the umbilicus, with an anterior channel at the base. Outer lip scalloped internally with external margin thickened or variciform.
Dimensions: Holotype: 1.82 mm in height x 1.72 mm in diameter (H/D = 1.05).

Remarks. *Crossea regularis* n. sp. has as differential characters as its small size, globose aspect and its lower spiral height; by the smaller number of spiral cords and not convex space between cords; and by the shape and the ornamentation of the variciform axial thickening.
The only other species of this genus with some similarity is *Crossea extrema* n. sp. from New Caledonia, which has a higher shell, with several axial ridges restricted to the end of the spire, the spiral cords are less prominent, the axial sculpture being curved between the closed cords, the outer lip with less prominent modifications.
Another small species of this genus is *Crossea sepcris* n. sp. from New Caledonia, but it is very different in view of the peripheral carinae and the numerous axial ridges.

Etymology. The specific name alludes to the regularity of the sculpture, in contrast with other species of the genus.

COMMENTS AND CONCLUSIONS.

The present study was carried out on the basis of the material collected by the MNHN and IRD and represents the first part of a work that will be continued with other genera of the family Conradiidae.

For the present genus, 11 species have been studied that have proved to be new to science. It is remarkable that all of them were collected at significant depths: 2 to more than 200 m deep; 4 at more than 300 m; and 5 at more than 400 m. Perhaps for this reason or because of their habitat (caves, rocky areas, corals, etc.) the material collected for each species has been minimal. Therefore, there are no data on their habitat, or about their soft parts and radular morphology.

The distribution of the species studied is irregular: the prevalence seems to correspond to New Caledonia, with 5 species; 2 were found in Fiji and another 2 in Solomon Is.; only one in Vanuatu and another one in Wallis & Futuna.

The morphology of those found in New Caledonia, appears to offer no doubt about their specific separation. The existence of strong axial and spiral sculpture, as well as of a periumbilical cord and the persistence of apertural thickenings, has allowed a clear differentiation in every case.

The size of the studied species is small but variable. Three species have a maximum dimension below 2 mm. Three are smaller than 3 mm; two were less than 4 mm in size, and three more are less than 5 mm in maximum dimension.

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Most of the material in this paper originates from numerous shore-based expeditions and deep water cruises, conducted since the 1980s by the MNHN /or by MNHN and Institut de Recherche pour le Développement (IRD) as part of the *Tropical Deep-Sea Benthos* programme in New Caledonia (BATHUS 2, EBISCO), Lifou Island (MUSORSTOM 6), the Solomon Islands (SALOMON 1, 2),Vanuatu (MUSORSTOM 8), Wallis & Futuna (MUSORSTOM 7), and Fiji (BORDAU 2, MUSORSTOM 10) (Principal Investigators: Bertrand Richer de Forges, Philippe Bouchet and Sarah Samadi). For station lists and context of the expeditions, see https://expeditions.mnhn.fr/ and Bouchet *et al.* (2008). We thank Philippe Maestrati and his team of MNHN volunteers (Danielle Plaçais, Mauricette Bourgeois, Danièle Grimal) and Virginie Héros for sorting the molluscs from a vast amount of expedition material; Virginie Héros for checking carefully the manuscript and for management of registration numbers and locality data; and Manuel Caballer for the photo of the type of *Crossea bellula* under MNHN Projet RECOLNAT (ANR-11-INBS-0004). Finally, we would like to thank Philippe Bouchet for access to the malacological resources of the MNHN expeditions.
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New records of marine littoral Gastropoda and Bivalvia in the Azores Archipelago (Northeast Atlantic Ocean)

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MOTS CLES. Nouvelles signalisations, Gastropoda, Bivalvia, mollusques marins littoraux, Açores.

ABSTRACT. The analysis of shell grit samples taken between 0 and 50 m from Faial, Pico and São Miguel revealed the presence of seven not yet reported marine species of molluscs from the Azores Archipelago, four gastropods species [*Caecum swinneni* Nofroni, Pizzini & Oliverio, 1997 (Caecidae), *Granulina* cf. *canariensis* Boyer, 2001 (Marginellidae), *Mitromorpha engli* Mifsud, 2001 (Mitromorphidae), *Discotectonica discus* (Philippi, 1844) (Architectonicidae)] and three species of bivalves [*Acar clathrata* (Defrance, 1816) (Arcidae), *Rhomboidella canariensis* (Odhner, 1932) (Mytilidae) and *Kelliopsis jozinae* van Aartsen & Carrozza, 1997 (Lasaeidae)]. These species are considered today as part of the Archipelago's fauna and illustrated here. *Notodiaphana atlantica* Ortea, Moro & Espinosa, 2013 (Notodiaphanidae) replaces *Retusa multiquadrata* Oberling, 1970.

RESUME. L'analyse d'échantillons de sable coquiller prélevés entre 0 et 50 m à Faial, Pico et São Miguel a révélé la présence de sept espèces de mollusques marins non encore répertoriées dans l'archipel des Açores, quatre espèces de gastéropodes [*Caecum swinneni* Nofroni, Pizzini & Oliverio, 1997 (Caecidae), *Granulina* cf. *canariensis* Boyer, 2001 (Marginellidae), *Mitromorpha engli* Mifsud, 2001 (Mitromorphidae) et *Discotectonica discus* (Philippi, 1844) (Architectonicidae)] et trois espèces de bivalves, [*Acar clathrata* (Defrance, 1816) (Arcidae), *Rhomboidella canariensis* (Odhner, 1932) (Mytilidae) et *Kelliopsis jozinae* van Aartsen & Carrozza, 1997 (Lasaeidae)]. Ces espèces sont considérées à ce jour comme appartenant à la faune de l'Archipel et sont illustrées ici. *Notodiaphana atlantica* Ortea, Moro & Espinosa, 2013 (Notodiaphanidae) remplace *Retusa multiquadrata* Oberling, 1970.

INTRODUCTION

The study of the benthic fauna of the Azores was initiated in the course of the 19th century by the launching of large seabed exploration expeditions in the North Atlantic Ocean. This enabled the collection of thousands of samples of deep-sea animals among them many benthic molluscs. The specimens of the dredging campaigns carried out by the expeditions of the « Josephine » were the subject of few comments by Jeffreys from 1878 to 1885.

Those of the « Travailleur » and the « Talisman » were reported by Locard (1897, 1898) and those of the dredgings carried out by « L'Hirondelle » and « La Princesse Alice » between 1888 and 1896 at the initiative of Prince Albert 1er of Monaco were extensively analysed by Dautzenberg (1889) and Dautzenberg & Fischer (1896). These authors are at the origin of the first faunistic inventories of mainly deep-sea benthic molluscs in the Azores and have contributed to the description of many previously unknown species. The inventory of intertidal molluscs, collected along the Azorean coasts at shallow depths, had begun earlier with a report written by the naturalist Drouët (1858) for the King of Portugal in which he mentioned the presence of 51 gastropods and 15 bivalves. It was not until the late

1990s and early 2000s that a new generation of young researchers was again conducting investigations related to the intertidal benthic fauna of the Archipelago. In the Biology Department of the University of the Azores, on the Ponta Delgada campus, Ávila and other researchers were very active on this topic (1998, 2000, 2005 among others). These works combined with that of Segers (2002), the illustrated checklist of infralittoral molluscs off Vila Franca do Campo (Martins et al. 2009), the checklist of the littoral gastropods from the Archipelago (Cordeiro et al. 2015) and the successive records of new species for the Azores (for example Paz Sedano et al. 2017 - Cacabelos et al. 2018) led to a total of 385 littoral molluscs species, 280 of which are gastropods distributed among 95 families, 90 bivalves, 8 cephalopods and 7 polyplacophores (Cacabelos et al. 2018) with a rate of endemism of 10,6 % (41 species).

Abbreviations

MNHN: Muséum national d'Histoire naturelle, Paris, France;
NMR: Natuurhistorisch museum Rotterdam, The Netherlands;
USC: Universidade de Santiago de Compostela (Museo de historia natural « Luis Iglesias »), Santiago de Compostela, Spain;
WoRMS: World Register of Marine Species.

Material

Littoral marine gastropods and bivalves are including here the intertidal species of molluscs up to 50 meters. 13 samples of shell grit were investigated (Table 1 and Fig.1). Beached and seaweed washing material was collected by Frank Swinnen (FS) in 2012 and by Roland Scaillet (RS) in 2017, all other samples were provided by a diver, Peter Wirtz (2012 - 2013).

Table 1. Sampling stations (capital letters between parentheses refer to the localities in Fig. 1)

Table 1					
Islands	**Localities**	**Shell grit** (Diver PW 2012/2013)			**Shell grit** (FS 2012 - RS 2017)
Faial	Monte da Guia (A)	35 m	40 m		
	Porto Pim (B)				Beached (FS)
Pico	São Mateus (C)	35 m	42 m	48 m	
	São Roque (D)	12 m	40 m		
	Porto Calhau (E)	8 m			
	Ilhéus da Madalena (F)	21 m			
Terceira	Porto de São Fernando (G)				Beached (FS)
São Miguel	Ponta Delgada (H)				Beached - Seaweed washing (FS)
	Vila Franca do Campo (I)				Beached - Rocks (RS)

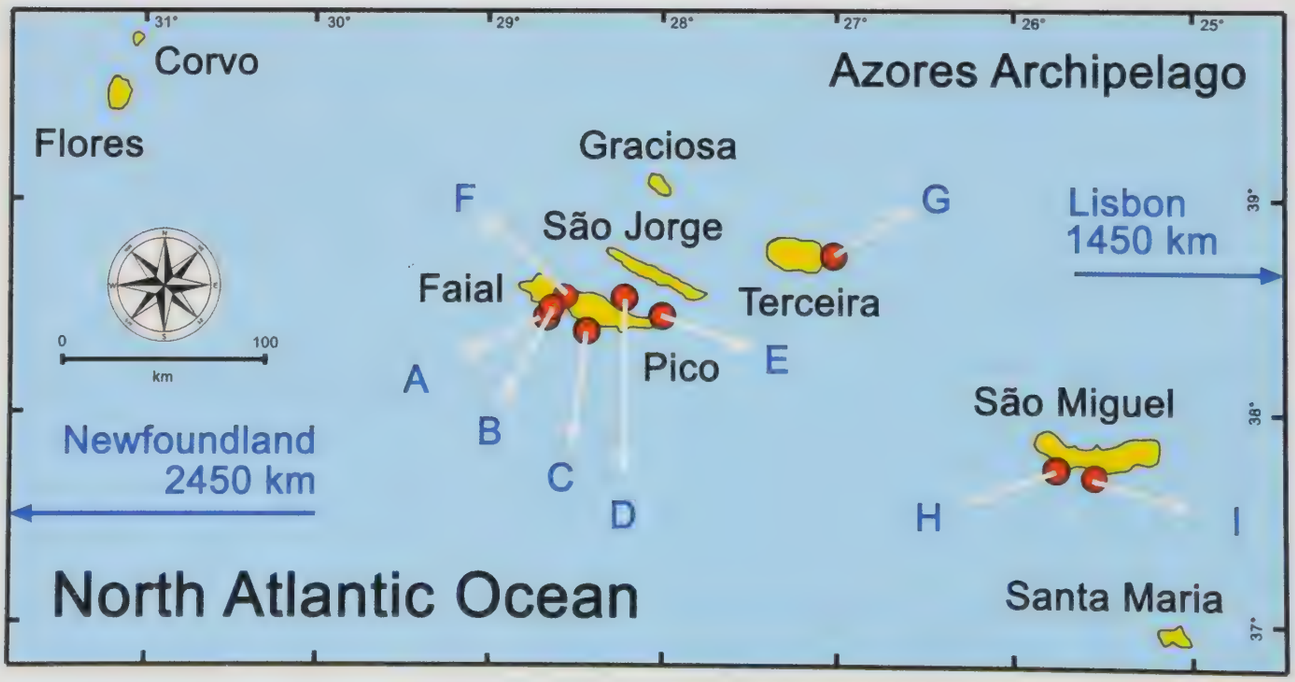

Figure 1. The Azorean Archipelago, geographical situation. A. Monte da Guia (Faial). B. Porto Pim (Faial). C. São Mateus (Pico), D. São Roque (Pico), E. Porto Calhau (Pico), F. Ilhéus da Madalena (Pico), G. Porto de San Fernando (Terceira), H. Ponte Delgada (São Miguel), I. Vila Franca do Campo (São Miguel).

RESULTS

142 shell-bearing gastropods, 38 bivalves and 3 polyplacophores were examined. Taking into account that gastropods without shell were by definition excluded from the working samples, it can be hypothesized that about more than half of Azorean littoral shell-bearing molluscs were present in the analysed samples. On the other hand, it is interesting to point out that four gastropods species were not part of the 2015 checklist (Cordeiro et al. 2015) updated in 2018 (Cacabelos et al. 2018). Three species of bivalves were absent from the 2010 list of bivalves (Martins 2010). These seven species are considered as new records for the Archipelago (Table 2).

Table 2. New records

Table 2		
Family	**Species**	**Locality**
Gastropoda		
Caecidae	*Caecum swinneni* Nofroni, Pizzini & Oliverio, 1997	Faial (A)
Marginellidae	*Granulina* cf. *canariensis* Boyer, 2001	Pico (C)
Mitromorphidae	*Mitromorpha engli* Mifsud, 2001	Pico (C)
Architectonicidae	*Discotectonica discus* (Philippi, 1844)	Pico (C)
Bivalvia		
Arcidae	*Acar clathrata* (Defrance, 1816)	Pico (C, D)
Mytilidae	*Rhomboidella canariensis* (Odhner, 1932)	Faial (A) Pico (C, D, F) São Miguel (H)
Lasaeidae	*Kelliopsis jozinae* van Aartsen & Carrozza, 1997	Faial (A) Pico (D)

DISCUSSION

Caecum swinneni Nofroni, Pizzini & Oliverio, 1997
(Caecidae)
Fig. 2C-D

Occurence in the Azores: Monte da Guia, 35m, Faial.

Caecum swinneni was presently known only from the Islands of Lanzarote and Tenerife (Canary Islands) (Nofroni et al. 1997). The shell has been described as such: small, white, semitransparent, moderately curved, slender, subcylindrical, septum bearing a protruding triangular mucro, apertural swelling sculptured with small circular rings and surface with marked longitudinal slightly coiled ridges. All these peculiar features are found on the specimen collected in Faial and make it unmistakable (Fig. 2C-D). Two paratypes (coll. CD & RS) from Lanzarote are figured for comparison (Fig. 2A-B). Other Caecidae, *Caecum gofasi* Pizzini & Nofroni, 2001, *Caecum wayae* Pizzini & Nofroni, 2001 present in the Azores have also longitudinal lines, but these are very fine, straight and not coiled (Pizzini & Nofroni 2001).

Granulina* cf. *canariensis Boyer, 2001
(Marginellidae)
Fig. 2E

Occurence in the Azores: São Mateus, 48 m, Pico.

Granulina canariensis is known from Fuerteventura and Gran Canaria (Canary islands) around 60-100 m to 180-240 m and is not recorded from Madeira (Segers et al. 2009). The holotype deposited at the MNHN (Paris, France) is here illustrated (Fig. 2F). This shell is quite large for the genus (average length 2.9 mm). Its columella is covered by a thick callus more developed towards the posterior part where it wraps the top of the shell (Boyer 2001).
In the Azores the genus *Granulina* is not listed in the Marginellidae family (Cordeiro et al. 2015). Although much smaller (half sized) than the Canarian specimens (Fig. 2G) (Rolán et al. 2011) this single shell from littoral water of Azores (Pico) strongly looks like them, particularly by the thickness of the columellar callus at the top of the shell (Fig. 2E). However, the inner margin of its labrum although finely crenulated bears fewer denticles.
It is known that molluscs species of Azores are often smaller than those found elsewhere what has been highlighted in bivalves (Morton et al. 2014). Because of the slight differences observed with the specimens of the Canary Islands we prefer to give it the name of *Granulina* cf. *canariensis*.

Discotectonica discus (Philippi, 1844)
(Architectonicidae)
Fig. 3A-B

Occurrence in the Azores: São Mateus, 48 m, Pico.

Discotectonica discus is known from the Bay of Biscay to West African coasts, including Madeira, Canary and Cabo Verde Archipelagos and into the Mediterranean Sea (Segers et al. 2009) and lives in the

Figure 2.
A-D. *Caecum swinneni* Nofroni, Pizzini & Oliverio, 1997. A-B. Paratypes, coll. CD-RS, Brussels, Belgium: Puerto del Carmen, 40-50 m, Lanzarote, Canary Islands. A. 2.4 x 0.5 mm. B. 2.0 x 0.4 mm. C-D. Monte da Guia, 35 m, Faial, Azores, 2.3 x 0.4 mm. D. Same specimen enlarged.
E. *Granulina* cf. *canariensis* Boyer, 2001. São Mateus, 48 m, Pico, Azores, 1.8 x 1.2 mm. **F-G.** *Granulina canariensis* Boyer, 2001. F. Holotype, MNHN-IM-2000-373, Paris, France: Lobos Island, 100 m, Fuerteventura, Canary Islands, 3.0 x 2.0 mm. G. In Rolán 2011, plate 62, fig. E, Fuerteventura, Canary Islands, 3.1 mm.

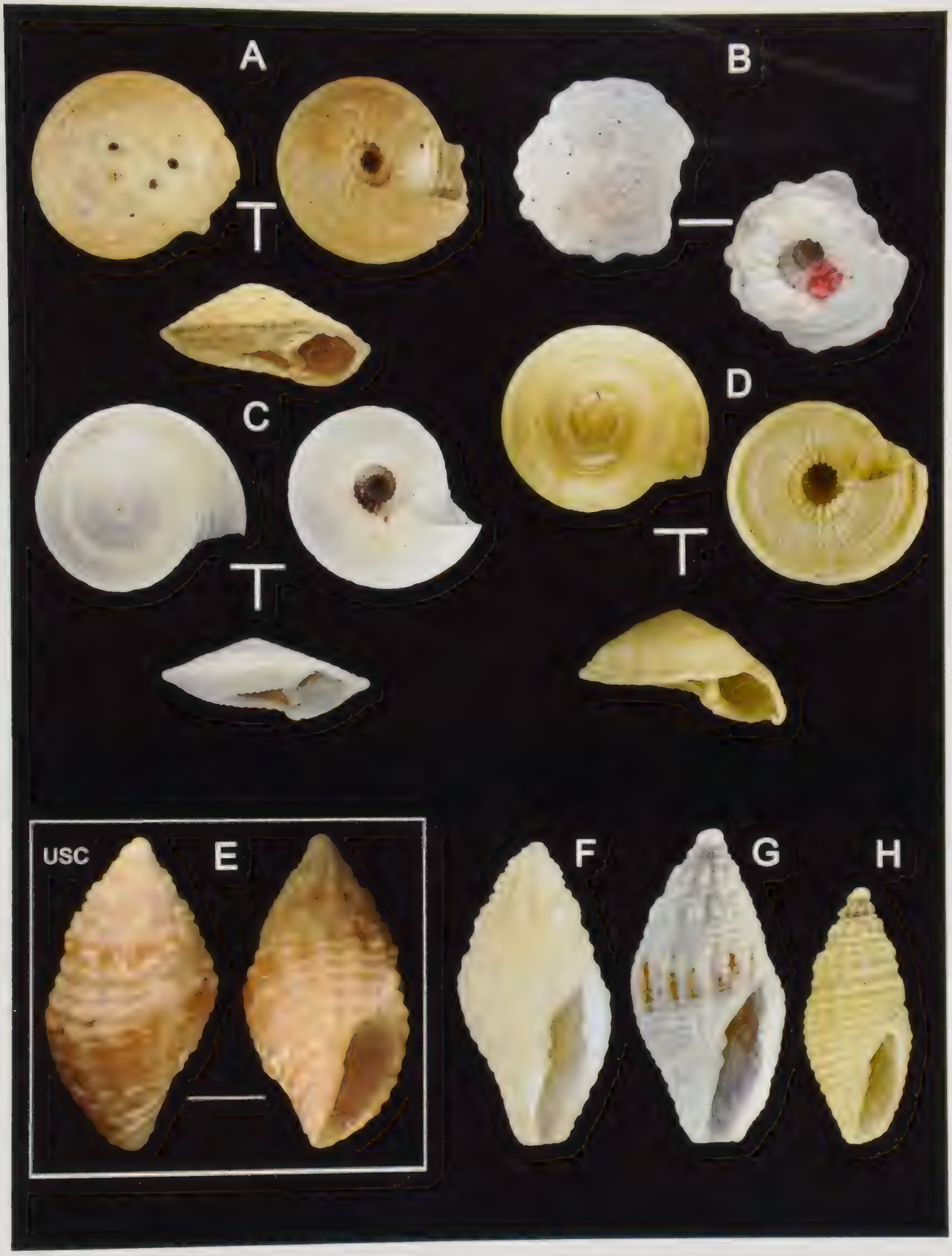

Figure 3.
A-C. *Discotectonica discus* (Philippi, 1844). A-B. São Mateus, 48 m, Pico, Azores, 12.6 x 11.6 mm (A) and 9.5 x 5.7 mm (B). C. Messine Strait, Italy, 13.1 x 11.6 mm.
D. *Basisulcata lepida* (Bayer, 1942). Off Martil, 120 m, Alboran Sea, Morocco, 19.3 x 16.4 mm.
E-H. *Mitromorpha engli* Mifsud, 2001. E. Paratype, ex coll. E. Rolán, Lanzarote, Canary Islands, 3.9 x 2.0 mm. F. Porto Novo, Lanzarote, Canary Islands, 3.6 x 2.1 mm. G-H. São Mateus, Pico. Azores. G. 48 m, 4.3 x 2.1 mm. H. 42 m, 3.5 x 1.4 mm.

circumlittoral floor and far beyond. In the same geographical area, a neighboring species, *Basisulcata lepida* (Bayer, 1942) (Fig. 3D) can already be found from 25 meters depth (Gofas 2011), but it differs by its sculpture, the concavity of its base and its different profile.

The two specimens of *Discotectonica discus* collected off São Mateus (Fig. 3A-B) at the upper limit of the infralittoral floor are in bad condition, with no color and one of them was strongly broken which made its identification difficult. Nevertheless, when compared with a Mediterranean specimen (Fig. 3C) the base of the unbroken shell shows a comparable convex profile. They differ also from *Psilaxis krebsii* (Mörch, 1875) illustrated by Martins et al. (2009, plate XV, fig. 253).

Mitromorpha engli Mifsud, 2001 (Mitromorphidae)
Fig. 3G-H

Occurrence in the Azores: São Mateus, 42 and 48 m, Pico.

Mitromorpha engli is an infralittoral shell known in the Canary Islands in Lanzarote (Fig. 3E-F) and in El Hierro. It is characterized by a dozen strong axial ribs extending over most of the body whorl and forming distinct tubercles at the crossing of the spiral cords, by the presence of an excavated sub-sutural groove. Its color is whitish with yellowish-brown spots. The inside of the outer lips is crenulate and sometimes has in its upper part one or two more pronounced teeth (Mifsud 2001).

Among the numerous specimens of Mitromorphidae found in the shell grit samples from Pico [*Mitromorpha azorensis* Mifsud, 2001 and *M. crenipicta* (Dautzenberg, 1889)], some with axial ribs intersected by strong spiral cords (Fig. 3G-H) have retained our attention because of their similarities with the specimens of the Canary Islands.

Notodiaphana atlantica
Ortea, Moro & Espinosa, 2013
(Notodiaphanidae)
Fig. 4B

Occurrence in the Azores: Ponta Delgada (beached), São Miguel. Many other localities in Faial and Pico (see Table 2).

This is not a new species, but a new name that has to be used as replacement for *Retusa multiquadrata* Oberling, 1970 in the updated lists.

Notodiaphana atlantica was subject of nomenclatural discussions (Ortea et al. 2013) and it is concluded so far that *Retusa multiquadrata* Oberling, 1970 [name used by Mikkelsen (1995), Segers et al. (2009), then by Cordeiro et al. (2015)] and *Notodiaphana atlantica* could be synonyms, the first being considered as *nomen dubium* until Oberling's type material will be traced and studied (Micali, 2014).

Whatever it is, the specimens from the different samples studied here (Fig. 4B) undoubtedly belong to the same species as the one illustrated by Mikkelsen (1995) (Fig. 4A). This Cephalaspidea is common in the littoral waters of the Archipelago and was found in almost all samples studied here.

Acar clathrata (Defrance, 1816) (Arcidae)
Fig. 4D

Occurrence in the Azores: São Mateus, 35 m and São Roque, 40 m, Pico, loose valves in all localities.

Acar clathrata is known in the Atlantic Ocean from Galicia to Morocco, Madeira, Canary and Cabo Verde Archipelagos and into the Mediterranean Sea. White in color, its sculpture is quite rough with strong radial ribs crossed by commarginal lamellae forming at the point of intersection nodules that pile up like tiles (Fig. 4D-E).

Figure 4.
A. *Retusa multiquadrata* Oberling, 1970. In Mikkelsen 1995, fig. 2E, off Ponta da Pirâmide, 14m, São Miguel, Azores, 2.0 mm. **B.** *Notodiaphana atlantica* Ortea, Moro & Espinosa, 2013. Ponta Delgada, São Miguel (beached), Azores, 2.2 x 1.3 mm. **C.** *Asperarca nodulosa* (Müller, 1776). W. Iceland, 400 m, 64°00'N-26°43'W, 13.3 x 7.9 mm.
D-E. *Acar clathrata* (Defrance, 1816). D. São Mateus, 35 m, Pico, Azores, 5.9 x 2.7 mm. E. Off Plakias, 70m, Creta, 9.2 x 4.9 mm.
F-G. *Rhomboidella canariensis* (Odhner, 1932). F. São Roque, 12 m, Pico, Azores, 2.3 x 1.4 mm. G. In Segers et al. 2009, plate 72, fig. 5, Funchal Bay, 100-150 m, Madeira, 2.2 mm.
H. *Crenella arenaria* Monterosato, 1875. Off Plakias, 70 m, Creta, 2.4 x 1.8 mm.
I-K. *Kelliopsis jozinae* van Aartsen & Carrozza, 1997. I. Monte da Guia, 35 m, Faial, Azores, 1.1 x 1.0 mm. J. In Segers et al. 2009, plate 78, fig. 12, Madeira, 2.0 mm. K. Off Favignana, 80m, Aegadian Islands, Sicily, 1.5 x 1.5 mm.

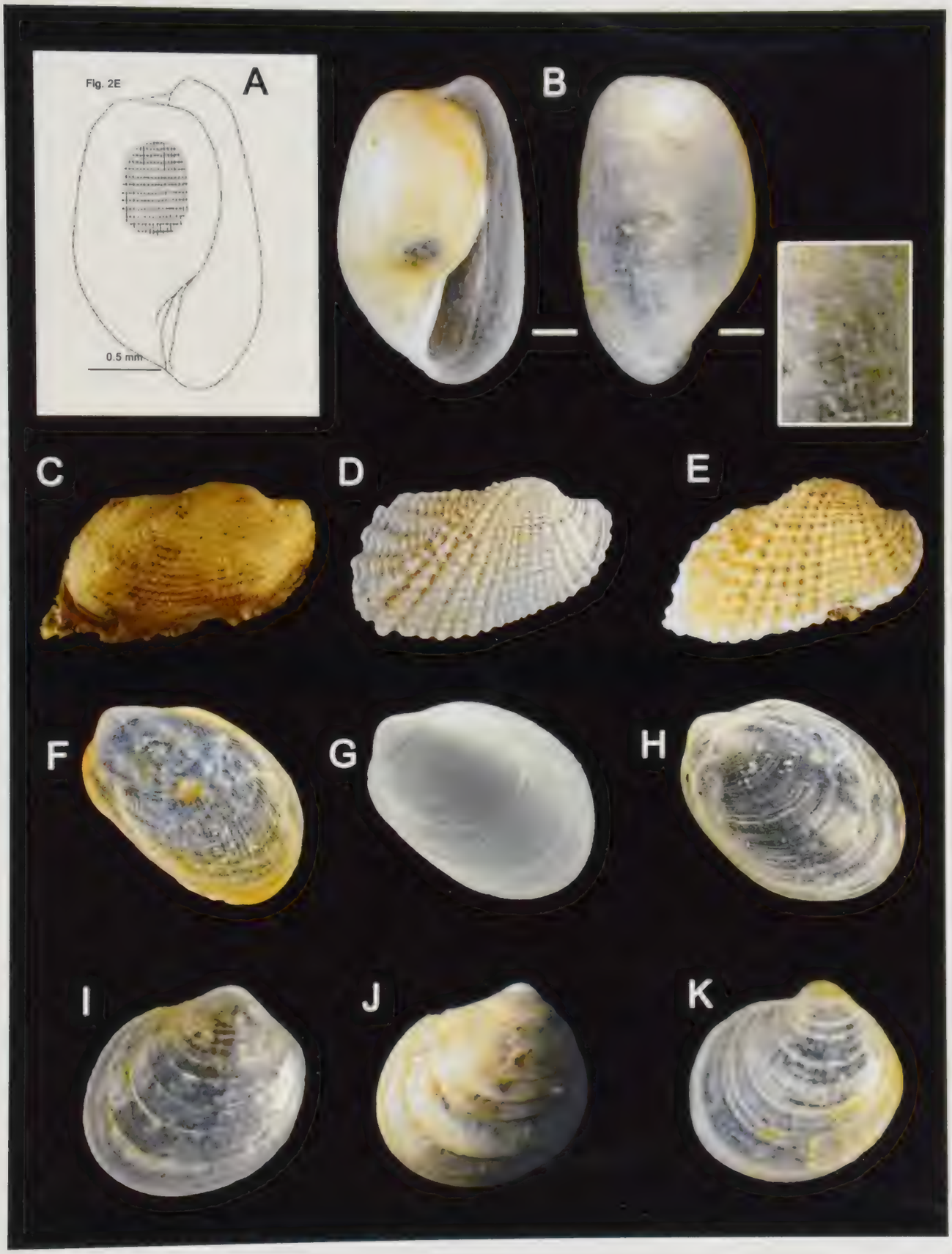
Fig. 2E
A
0.5 mm
B
C
D
E
F
G
H
I
J
K

A species of similar appearance, *Asperarca nodulosa* (Müller, 1776) (Fig. 4C) was reported from the Azores (Martins et al. 2009) and disappeared in Martins (2010). Compared to *A. clathrata*, *A. nodulosa* is less rough, brown in color and bears posteriorly lamellae that end in chitinous extremities. The shell represented on plate XVIII - 300 (Martins et al. 2009) could have been misidentified but the illustrations are not clear enough to draw a definitive conclusion.

Rhomboidella canariensis (Odhner, 1932)
(Mytilidae)
Fig. 4F

Occurrence in the Azores: São Roque, 12 m, Pico. Many other localities in Pico and Faial (see Table 2), loose valves in all localities.

Rhomboidella canariensis lives in the Madeira, Selvagens and Canary Archipelagos. It is new for the Azores (Fig. 4F) and was probably confused until today with *Crenella arenaria* Monterosato, 1875 that appears in the list of Azorean shells (Martins 2010) without a picture that can objectify the determination. *C. arenaria* is illustrated in the data bank of the NMR (n° 38802) as an Azorean shell. According to Gofas (2011), the sculpture of *C. arenaria* is exclusively composed of fine commarginal striae with no trace of radial striations (Fig. 4H). Shell n°38802 was misidentified, it is *Rhomboidella canariensis* characterized by its large smooth early stage occupying half the shell followed by fine radial striations. The same misidentification appears also in Rolán et al. 2011 (plate 105, figs R-S). It is correctly illustrated in Segers et al. 2009 (plate 72-5) (Fig. 4G). However, this does not exclude that *C. arenaria* is present in the Azores Archipelago.

Kelliopsis jozinae van Aartsen & Carrozza, 1997
(Lasaeidae)
Fig. 4I

Occurrence in the Azores: Monte da Guia, 35 m, Faial. Many other localities in Faial, Pico and São Miguel (see Table 2), loose valves in all localities.

Kelliopsis jozinae is a small circumlittoral bivalve whose distribution is poorly known. Reported first in the Mediterranean Sea (30-400 m) and in the Northeastern Atlantic from the Shetlands (van Aartsen & Carrozza 1997) and more recently reported from the Madeira Archipelago (407 m) (Segers et al. 2009). For comparison one specimen from Faial (Fig. 4I) is illustrated here together with specimens from Madeira (Fig. 4J) and Sicily (Fig. 4K).

CONCLUSIONS

The identification of these species considered as « new » for the Azores shows that the faunistic inventory of littoral marine molluscs of this zoogeographical region is far from complete and that it should encourage researchers to continue collecting shell grit samples along the coast or in shallow waters all around the islands of the Archipelago. It's a time-consuming job that remains to be done but the results are rewarding.

NOTE

All the shells illustrated are part of the author's collections, except when indicated. We follow the taxonomic nomenclature of WoRMS (MolluscaBase 2019).

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First record of the Hedge Snail *Hygromia limbata* (Draparnaud, 1805) (Gastropoda: Hygromiidae) in Belgium

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KEYWORDS. Hedge Snail, *Hygromia limbata limbata,* species introduction, geographical distribution, invasive species, population expansion, landsnails, Hygromiidae.

ABSTRACT. A fresh shell of the Hedge Snail *Hygromia limbata limbata* (Draparnaud, 1805) was discovered in November 2018 in a hedge in Rixensart (Walloon Brabant, Belgium). This is the first record of this species in Belgium. This Atlantic range of this species is progressing northeast, now reaching Belgium. The persistance of a living population in the territory is not yet proven, but this species could potentially become more frequent in the future, as is the case with the recent colonization of *Hygromia cinctella* (Draparnaud, 1801).

RÉSUMÉ. Une coquille fraiche de l'Hélice des ruisseaux *Hygromia limbata limbata* (Draparnaud, 1805) a été découverte en novembre 2018 dans une haie à Rixensart (Brabant wallon, Belgique). Cette mention constitue la première observation de cette espèce en Belgique. Cette espèce à tendance atlantique progresse vers le nord-est de son aire, atteignant donc maintenant la Belgique. Le maintien d'une population sur le territoire n'est pas encore prouvé, mais cette espèce pourrait potentiellement devenir plus fréquente dans le futur, à l'instar de la colonisation récente d'*Hygromia cinctella* (Draparnaud, 1801).

INTRODUCTION

During a stop at a gas-station on November 9th, 2018, the first author found a fresh empty shell in a hedge. Originally thinking that it was an interesting specimen of *Monachoides incarnatus* (O.F. Müller, 1774) with a significant keel, a characteristic also evocating *Hygromia cinctella* (Draparnaud, 1801), the specimen was collected. After examination, a series of morphological traits do not correspond to *M. incarnatus*: the ombilicus is largely covered; the shell does not have the microstructure typical of *M. incarnatus*; the coloration is not typical of this species. Based on these characteristics, it appears that the specimen corresponds to *Hygromia (Riedelia) limbata limbata* (Draparnaud, 1805) (Hygromiidae), a species that has never before been reported in Belgium.

DESCRIPTION OF OBSERVATION

Collecting site. The shell was collected at the coordinates 50°42'25"N, 4°31'16"E at the city of Rixensart (Walloon Brabant, Belgium), at the Jean XXIII Avenue, near the gas station of the Kennedy Avenue (Fig. 2B-D). The specimen was on the ground under a small hedge of small coniferous trees (thujas). The neighborhood is a sub-urban zone with numerous houses with gardens, and many hedges and trees; there is also a cultivated field nearby. No new prospections were carried out to search for other specimens, but a living population could potentially be present. Its status as a reproductive species in Belgium remains unknown at this stage.

Shell description. Dimensions: 9.9 mm (height) x 14.1 mm (width) (Fig.1 A-D). These dimensions are

within the normal range of the species (height 8-14 mm - width 12-17 mm) (Kerney & Cameron, 1999; Welter-Schultes, 2012; Cadevall & Orozco, 2016). The shell is very light brown, slightly translucent, with a slight, white-colored keel on the periphery of the shell. The second-to-last whorl has a more accentuated keel. The shell has more than 5 whorls. The individual was mature, with a complete aperture. The whorl descends slightly near the aperture, which shows a white inside lip, with a reflected margin. The umbilicus is very narrow, and partly covered by the reflected columellar margin. The shell has numerous oblique longitudinal growth striations, but remains slightly shiny. The specimen belongs to the subspecies *H.l. limbata*; *H.l. sublimbata* being located in the Vienne department of France, with conchological differences not observed in our specimen.

DISCUSSION

No confusion is possible with the closed species *Hygromia cinctella* as the shell has more convex whorls, with a shallower suture, and with a complete aperture.

Hygromia limbata is known as a typical Atlantic species, with a distribution ranging from north-eastern Spain (Prieto & Puente, 1992) to western France (Welter-Shultes, 2012; Audibert & Bertrand, 2015) (Fig.2.A.). In France, the species is common in the West, from the Pyrenees to Brittany (Fig. 4A-B). *H. limbata* is also present in Normandy and Picardie (Vilvens et al., 2012; Welter-Schultes, 2012; Audibert & Bertrand, 2015; Gargominy, 2018) (Fig. 3). It has also recently been reported in a couple of departments in the North of France, notably in Pas-de-Calais and in the Aisne (reported respectively in 2008 and in 2010 by X. Cucherat in CardObs, in Gargominy, 2018). In the 1910's, an introduced population was discovered in the Devon in England (Ellis, 1926; Kerney, 1999), and several decades later, the species is well-established in the south of England, and ranges all the way to the Worcestershire area (Whitehead, 2008).

It seems that *H. limbata* tends to extend its distribution in the North-East of its range. This species has colonized Britain in the twentieth century, and is considered to be a recent arrival in northern France (Limondin-Lozouet & Preece 2004). However, fossil sediments show that *Hygromia limbata* was present in Normandy during the Holocene 6500 yr BP (Limondin-Lozouet & Preece, 2004).

In its range, *H. limbata* is found in forests, shrubs, hedges, meadows, in lower vegetation (Welter-Shultes, 2012; Audibert & Bertrand, 2015; Cadevall & Orozco, 2016). In England, *H. limbata* is found in moist, grassy habitats among herbage and ground litter in gardens and other disturbed places (Kerney, 1999). The Rixensart site has all the characteristics to welcome the species.

The cause of the introduction of this *H. limbata* remains unknown, but there is a high probability that man has involuntary introduced this land snail by anthropochory, given the distances that separates it from the nearest known populations. The most probable is an introduction by importation of plants from France or England. Vehicular anthropochory, with individuals attached to a car or train, is improbable, even if this has been observed with xerophilous species, which climb grass, poles and sometimes vehicles during hot temperatures (Hulme et al., 2008; Kurek & Najberek, 2009). This behaviour has not been observed in *H. limbata.* Introduction during the importation of materials (for instance, earth, stones, or building materials) is another interesting hypothesis.

Of course, one shell is not a proof of the existence of a settled population, but *H. limbata* could be more frequently observed in Belgium in the future. A related species, *H. cinctella*, observed for the first time in 1994, has colonized the entire country in two decades (Van den Neucker & Scheers, 2014; Delcourt & Vilvens 2017). *H. limbata* could be the next anthropophilous meridian species to settle in Belgium, after *H. cinctella, Tandonia budapestensis* (Hazay, 1860), *Arion vulgaris* Moquin-Tandon, 1855, *Ambigolimax valentianus* (Férussac, 1822), *Eobania vermiculata* (Müller, 1774), *Monacha cantiana* (Montagu, 1803) and *Cernuella virgata* (da Costa 1778) (i.e. Delcourt & Vilvens, 2015). Climate may have limited the arrival of these species of southern origin in the past, but recently, the warming climate, in particular the mild winters (especially in urban areas), may have created more welcoming conditions.

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Figures 1-4

1. Shell of *Hygromia limbata limbata* discovered in Rixensart (Belgium) in November 2018. A. Dorsal view; B. Ventral view; C. frontal view; D. lateral view.

2. A: Approximative range map of *Hygromia limbata* (from Welter-Shultes, 2012, redrawn); B: localization of the city of Rixensart (Belgium) where the shell was collected; C: detailed view (Google Earth ©) of the quarter with the localization of the discovery area (yellow arrow); D: picture of the hedge where the shell was found.

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New species of Conradiidae Golikov & Starobogatov, 1987 (= Crosseolidae Hickman, 2013) (Gastropoda: Trochoidea) from the Tropical Indo-Pacific II. The genus *Crosseola* and the description of *Crossolida* n. gen.

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KEYWORDS. Gastropoda, Trochoidea, Conradiidae, Crosseolidae, Crosseola, Indo-Pacific, new species.

ABSTRACT. New species of crosseolid vetigastropods, obtained during several expeditions in the Indo-West Pacific, organized by MNHN and IRD, are studied. In this second part we describe 23 species of the genus *Crosseola* Iredale, 1924, of which 19 are new. All these species are compared with the previously known species in this genus. A new genus is described and includes three new species and one which was previously included in the genus *Crosseola*.

RESUMEN. Se han estudiado nuevas especies de vetigastrópodos croseólidos obtenidos en varias expediciones en el Índico y en el Pacífico Occidental organizadas por el MNHN y IRD. En el presente trabajo (parte II) se estudian 23 especies del género *Crosseola* Iredale, 1924, de las cuales 19 son nuevas, siendo descritas y representadas aquí. Todas estas especies son comparadas con las previamente conocidas en este género. Un nuevo género es descrito en el cual se incluyen tres nuevas especies, además de otra descrita anteriormente en otro género diferente.

INTRODUCTION

The aspects of the Family Conradiidae Golikov & Starobogatov, 1987, and the genera included in this family were already introduced in the first part of the present study (Rubio & Rolán, 2019). In that introduction the genus *Crosseola* was thoroughly described.

Material and methods

The material used for the present work was obtained during several expeditions in the Indo-Pacific organized by MNHN and IRD from 1977 to 2014 and from the collection of Sandro Gori (Italy):

BENTHEDI (1977) on board of *Le Suroît* Mozambique Channel (doi.org/10.17600/77003111)
MUSORSTOM 3 (1985) on board of R/V *Coriolis*, Philippines (doi.org/10.17600/85005911)
SMCB (1991) on board R/V *Marara*, French Polynesia)
BATHUS 1 (1993) on board of R/V *Alis*, New Caledonia (doi.org/10.17600/93000350)
BATHUS 2 (1993) on board R/V *Alis*, New Caledonia. (doi.org/10.17600/93000360)
MUSORSTOM 8 (1994) on board R/V *Alis*, explored the Vanuatu Archipelago. (doi.org/10.17600/94100040)
MUSORSTOM 10 (1998) on board R/V *Alis* explored the Fijian Archipelago. (doi.org/10.17600/98100080)
TAIWAN 2001 (2001) on board of *Chung Tung Long No.26*
SALOMON 1 (2001) on board R/V *Alis* surveyed the central part of the Solomon Islands, from Guadalcanal to Malaita and Makira. (doi.org/10.17600/1100090)
PANGLAO 2005 (2005) on board of R/V *DA-BFAR*, Philippines
PAPUA NIUGINI (2012) on board of R/V *Alis*, Papua New Guinea (doi.org/10.17600/18000841)
MADEEP (2014) on board of R/V *Alis*, Bismarck and Solomon seas (doi.org/10.17600/14004000)

All the material studied in the present work is constituted by empty shells, obtained in the sediments. The shells were photographed at the Scanning Electron Microscopy Center (SEM) in the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo and in the Centro de Apoyo Científico y Tecnológico of the University of Santiago de Compostela (CACTUS).

Abbreviations

AMS: Australian Museum, Sydney, Australia.
MNHN: Muséum national d'Histoire naturelle, Paris, France.
IRD: Institut de Recherche pour le Développement, Paris, France.
SAMC: South African Museum, Cape Town, South Africa.
CSG: collection of Sandro Gori.

SYSTEMATICS

VETIGASTROPODA Salvini-Plawen, 1980
Superfamily **TROCHOIDEA** Rafinesque, 1815
Family **CONRADIIDAE** Golikov & Starobogatov, 1987
Genus ***Crosseola*** Iredale, 1924

Crosseola Iredale, 1924: 183, 251. Type species by original designation: *Crossea concinna* Angas, 1867. Recent, NSW, Australia.

Diagnosis. (From Hickman, 2013). Shell small: Maximum adult shell size of approximately 5 mm (larger than most conradiids. Umbilical keel strongly developed and punctate, separated from the columella by a deep narrow groove (pseudo-umbilicus).
The columellar lip presents a prominent basal pit in the type species. A shallow anterior notch, prominently developed projects from the base of the columella. Sculpture finely cancellate to punctate, resulting from incomplete fusion of axial and spiral elements. A decrease in size and spacing of punctae can be seen on later whorls, and it is also present on a thickened labial varix which only appears as a terminal growth feature in adults.

Habitat. It is not well known. They have been found to inhabit from intertidal ecosystems to 200 m deep. There is only one mentioned case (see *C. indigaxial* n. sp. below) of it being found in a rocky bottom with caves. The shells were always collected in sand grit. *Crosseola concinna*, type species of the genus, occurs intertidally at Long Reef, New South Wales, Australia (Hickman, 2013).

Remarks. Hickman (2013) noted: "The robust, globose to turbinate shells are easily recognized by the characteristic sculpture, the unique umbilical keel, the narrow pseudo-umbilicus, and the distinctive channeled notch in the basal lip. The prosocline outer lip is shallowly sinuate in some species."
Until now, no living animal could be observed and consequently there is no information on its external anatomy.
Bathymetrically, species of this genus are present from the intertidal zone to bathyal depths.
Species of *Crosseola* have been found in Tertiary substrata.
In Australia the first appearance of the genus is an undescribed Eocene species (Buonaiuto, 1979). In New Zealand the genus ranges in time from the Miocene (Otaian) to Recent.
The type species is distributed from New South Wales to Tasmania, Victoria, and South Australia. But the genus extends from Japan to Australasia, the Indian Ocean, South Africa and the Atlantic Ocean (Rubio & Rolán, 2019).
Rubio & Rolán (2014) described *Crosseola gorii*, the first record of the genus from the West coast of Africa. Later, Rolán, Gori & Rubio (2016) and Rubio & Rolán (2017a, 2017b) described new Atlantic and Indo-Pacific species.
Currently there are 30 extant and fossil species described:

Extant species

Crosseola bellula (A. Adams, 1865)
Crosseola concinna (Angas, 1867)
Crosseola cancellata (Tenison-Woods, 1878)
Crosseola striata (Watson, 1883) [(in Hickman (2013: 9, fig. 3 A-G)].
Crosseola consobrina (May, 1916) [(in May (1916: 97, pl. 7, fig. 37)].
Crosseola cuvieriana (Mestayer, 1919)
Crosseola errata Finlay, 1926
Crosseola favosa Powell, 1937
Crosseola intertexta Powell, 1937
Crosseola bollonsi Dell, 1956
Crosseola pseudocollonia Powell, 1957
Crosseola foveolata (Barnard, 1963)
Crosseola gorii Rubio & Rolán, 2014
Crosseola brasiliensis Rubio & Rolán, 2017
Crosseola caribbeae Rubio & Rolán, 2017
Crosseola madagascariensis Rubio & Rolán, 2017
Crosseola marquesensis Rubio, Rolán & Letourneux, 2017
Crosseola ordinata Rubio & Rolán, 2017
Crosseola similiter Rubio & Rolán, 2017
Crosseola solomonensis Rubio & Rolán, 2017

Fossil species

Crosseola princeps (Tate, 1890)
Crosseola semiornata (Tate, 1893) [in Darragh (1970: 194)]
Crosseola sultan Finlay, 1930
Crosseola proerrata Finlay, 1930
Crosseola tenuisculpta Laws, 1936
Crosseola munditia Laws, 1936

Crosseola sinemacula Laws, 1939
Crosseola waitotara Laws, 1940
Crosseola emilyae Laws, 1950
Crosseola henryi Laws, 1950

The genus *Crosseola* is very heterogeneous; in general the species described are identified with different morphotypes such as *C. bellula, C. concinna, C. cuvieriana, C. consobrina* or *C. foveolata*. Each and every one of them posseses the fundamental morphological characters described for the genus (Hickman, 2013); however, they are so different from each other that they could be grouped into a new genus for each morphotype.

Crosseola bellula (A. Adams, 1865)
Fig. 1A-E

Crossea bellula A. Adams, 1865: 323 (Type locality: Gotto Islands, Japan, 64 ftms).
Crosseola bellula (A. Adams, 1865) — Rubio & Rolán, 2017a: 18.
Dolicrossea bellula (A. Adams, 1865) — Hasegawa & Fukuda, 2017: 813, pl. 83, fig. 1 (misidentified species).

Type material. 2 syntypes MNHN-IM-2000-31037. Collection A. Adams et Crosse. Coll. of Journal de Conchyliologie. Examined by photographs.

Description. The following is based on syntypes from the MNHN. Shell of very small size (<2.5 mm in diameter), robust, turbiniform, formed by about 4 whorls separated by an evident suture, not carinated.
The protoconch is smooth formed by ¾ of a whorl. The teleoconch has almost 3 ¼ whorls and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules.
The entire surface of the teleoconch is covered by microgranules. In the first two whorls, cords and ribs form a regular reticle of rectangular/quadrangular spaces; there are no nodules at the intersection points; abapically, at the last whorl, the spaces become narrower and oval. There is no predominance of axial or spiral ornamentation; however, the spiral cords project slightly over the axial ribs, but without angulating the rounded periphery of the teleoconch. In apertural view, there can be seen 4 spiral cords (1 subsutural and 3 peripheral) at the first whorl, 3 at the second and 10-12 in the last one. After the first whorl, the subsutural cord disappears gradually and a larger space, crossed by longer axial ribs, is formed. At the base, around the periumbilical cord, there is another wide area, without cords, crossed only by sinuous axial ribs and in some cases anastomosed. There are no variciform axial thickenings.
A prominent periumbilical cord, formed by successive thick oblique ribs, borders and delimits the umbilicus. Umbilicus totally covered by an extension of the columellar lip.
Aperture rounded, prosocline; columella arched, very wide at its base and reflected towards the umbilicus, coming to cover it completely, with an anterior channel at the base. Outer lip with smooth margin, not thickened or variciform.
Dimensions: The syntypes measure 2.00 mm in diameter (Fischer-Piette, 1950: 70).

Habitat. Collected at 64 fms (A. Adams, 1865).

Distribution. Only known from the type locality.

Remarks. *Crossea bellula* was described by A. Adams (1865) from Gotto Islands, Japan, but was not accompanied by any illustration. It was three years later that A. Adams (1868: Pl IV, fig. 10) provided the first illustration of the species.
Rubio & Rolán (2017a), after examining the syntypes considered that this species was assigned to *Crosseola*, since they had the morphological characters described by Hickman (2013) for the genus, and because of its similarity to other species as *C. similiter* n. sp. and *C. favosa* Powell, 1937.
Hasegawa & Fukuda (2017) misidentified the species and placed it in the family Elachisinidae Ponder, 1985, genus *Dolicrossea* Iredale, 1924. However, the figured species was a different one, probably undescribed.
In our opinion, *Crosseola bellula* represents one of the 4-5 morphotypes of the genus *Crosseola*, which can probably be constituted in new genera after a detailed anatomical and molecular study.

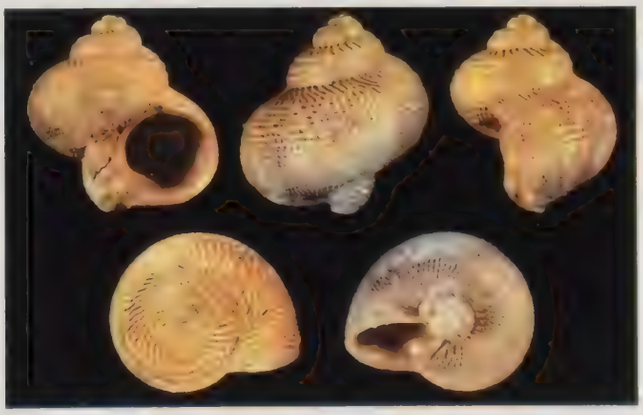

Figure 1A-E
Crosseola bellula (A. Adams, 1865). Syntypes MNHN-IM-2000-31037. Collection A. Adams et Crosse.

Crosseola foveolata (Barnard, 1963)
Fig. 2A-E

Turbo foveolatus Barnard, 1963: 216, fig. 6 (Type locality: 34°5'S-25°42'E, off Cape Recife, 95 m).
Crosseola foveolata (Barnard, 1963) — Herbert, 2015: 82, figs 6M-N, 9I.

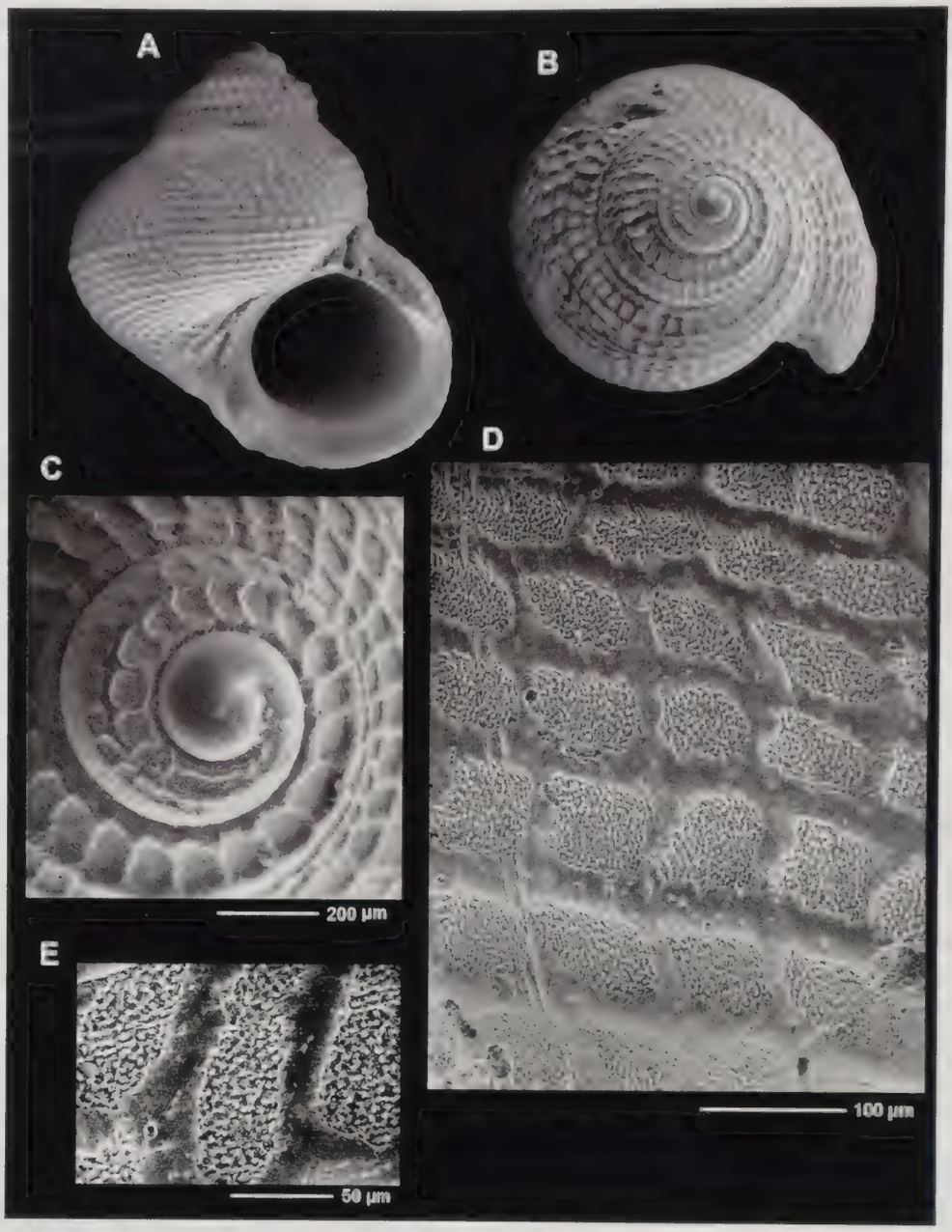

Figure 2A-E
Crosseola foveolata (Barnard, 1963). A-B. Shell, 2.62 mm, South Africa, 35°40'S-21°59'E, 165 m (MNHN); C. Protoconch; D-E. Sculpture and detail.

Type material. *Turbo foveolatus* Barnard 1963. Syntypes in SAMC (A9284).

Material examined. VEMA, stn 28, 1 s, South Africa, 35°40'S-21°59'E, 165 m (MNHN).

Description. See the original description in Barnard (1963).

Shell of very small size (<3.00 mm), robust, turbiniform, almost as wide as high, formed by 4.1 whorls, rounded periphery and narrowly umbilicated.
The protoconch is rough, formed by 0.8 whorls, with a spiral cordlet and has a size of 300 µm in diameter.
The teleoconch has 3.1 whorls separated by a shallow suture. Ornamentation formed by spiral cords, axial ribs and microgranules.
Cords and ribs form a regular reticle of rectangular/quadrangular spaces; at the last whorl, the spaces become narrower and elongated; their great number provides the surface of the teleoconch with a foveolate aspect, like covered by multiple holes. There is no predominance of axial or spiral ornamentation.
In apertural view, there can be seen 3 spiral cords (1 subsutural and 2 peripheral) at the first whorl, 3 at the second and 20-22 in the last one. There are no variciform axial thickenings.
The microgranules cover only the reticular space.

A periumbilical cord, formed by successive oblique riblets, borders and delimits the umbilicus, which is reduced to a narrow fissure.
Aperture rounded, prosocline; columella arched, reflected towards the umbilicus, wide and with an anterior and barely visible channel at its base. Outer lip with a smooth margin that is not thickened nor variciform.
Dimensions: The figured shell is 2.56 mm in diameter and 2.33 mm in height (H/D: 0.91).

Habitat. Circalittoral-bathyal species dredged at 91-285 m in Agulhas Bank and at 165 m in Vema Bank.

Distribution. Agulhas Bank, from off Algoa Bay area to off Cape Infanta (no data for living specimens) (Herbert, 2015). Vema Bank, from off Cape Town.

Remarks. Herbert (2015) considered the reticulated-foveolar sculpture of *Turbo foveolatus*, as a reminiscent of the early whorls of *Crosseola concinna*, so he placed it, although with some reservation, in the genus *Crosseola*, because he suspected that it might belong to an undescribed crosseolid genus (foveolar means a surface with a sculpture of small fovea or holes).

Crosseola inverta (Hedley, 1907)
Fig. 3A-F

Crossea inverta Hedley, 1907: 501-502, pl. 17, fig. 15
Crosseola inverta (Hedley, 1907): Cotton, 1959: 204.

Type material. Holotype AMS C.21793.

Type locality. Great Barrier Reef, Capricorn Group, Masthead Island, Queensland, Australia. 31-37 m depth, 23°31'58.8'S, 151°45'0'E.

Material examined. BATHUS 2, stn DW717, 1 s, S New Caledonia, S Ile des Pins, 22°44'S-167°17'E, 350-393 m (MNHN).

Description. Original description in Hedley (1907).
Shell of small size (<4.00 mm), with a biconical appearance, robust, turbiniform, formed by 4.8 whorls, carinate and narrowly umbilicate.
The protoconch protrudes, has 0.8 whorls, a smooth surface and a size of 160 µm in diameter.
The teleoconch has 4 whorls and is peripherally carinate in the last and fourth whorl. Ornamentation formed by spiral carinae, spiral cords, axial ribs and microgranules.
In the first two and a half whorls, cords and ribs form a regular reticle of rectangular/quadrangular spaces and low nodules at the points of intersection. In the last whorl and a half, there is a raised peripheral carina, with a sharp margin and with thin and short oblique ribs on each side; at the same time in the interspaces, new intermediate cords appear, doubling their number in the last whorl, also increasing the number of axial ribs, and giving the effect of small perforations over the entire surface.
A prominent periumbilical cord (funicle), formed by successive axial riblets, borders and delimits the umbilicus; it appears in the parietal zone and separates from the base abapically, forming two umbilical orifices, one in the parietal zone and the other in the columellar one.
Aperture rounded, prosocline; columella thick and arched, very wide at its base and reflected towards the umbilicus, with a prominent anterior channel at the base. Outer lip thick, with smooth margin, not thickened or variciform.
Dimensions: the shell photographed measures 3.61 mm in height and 3.29 mm in diameter (H/D: 1.10).

Habitat. Infralittoral to bathyal species. Collected at 31-37 m in Queensland, Australia (Hedley, 1907). Dredged in New Caledonia at 350-393 m depth.

Distribution. Queensland, Australia and New Caledonia.

Remarks. Hedley (1907) considered *Crossea inverta* close to *Crosseola biconica* (Hedley, 1902), from which it differs by being larger, proportionally broader, with a lower spire and a heavier funicle.
The morphological features of *C. inverta* make it an unmistakable species, totally different from the other species studied up to now.

Crosseola delicata n. sp.
Fig. 4A-E

Type material. Holotype MNHN-IM-2000-34417 (Fig. 4A) and one paratype MNHN-IM-2000-34418 (Fig. 4B).

Type locality. NE coasts Taiwan, off Tashi, 24°48'N-122°07'E, 248-257 m (TAIWAN 2001: stn CP101).

Material examined. TAIWAN 2001: 2 s, NE coasts Taiwan, off Tashi, stn CP101, 24°48'N-122°07'E, 248-257 m (type material).

Description. Shell of small size (<5.00 mm in diameter), turbinate, with a high spire formed by 4 ¾ whorls, separated by a marked suture, not carinated and narrowly umbilicated.
The protoconch is formed by ¾ of a whorl, with a smooth surface and has a size of 230 µm in diameter.
The teleoconch has 4 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and microgranules. Cords and ribs cover the entire surface of the teleoconch, forming a regular reticle of rectangular/quadrangular spaces; there are no nodules at the intersection points. There is no predominence of axial or spiral ornamentation although the spiral cords project slightly more but

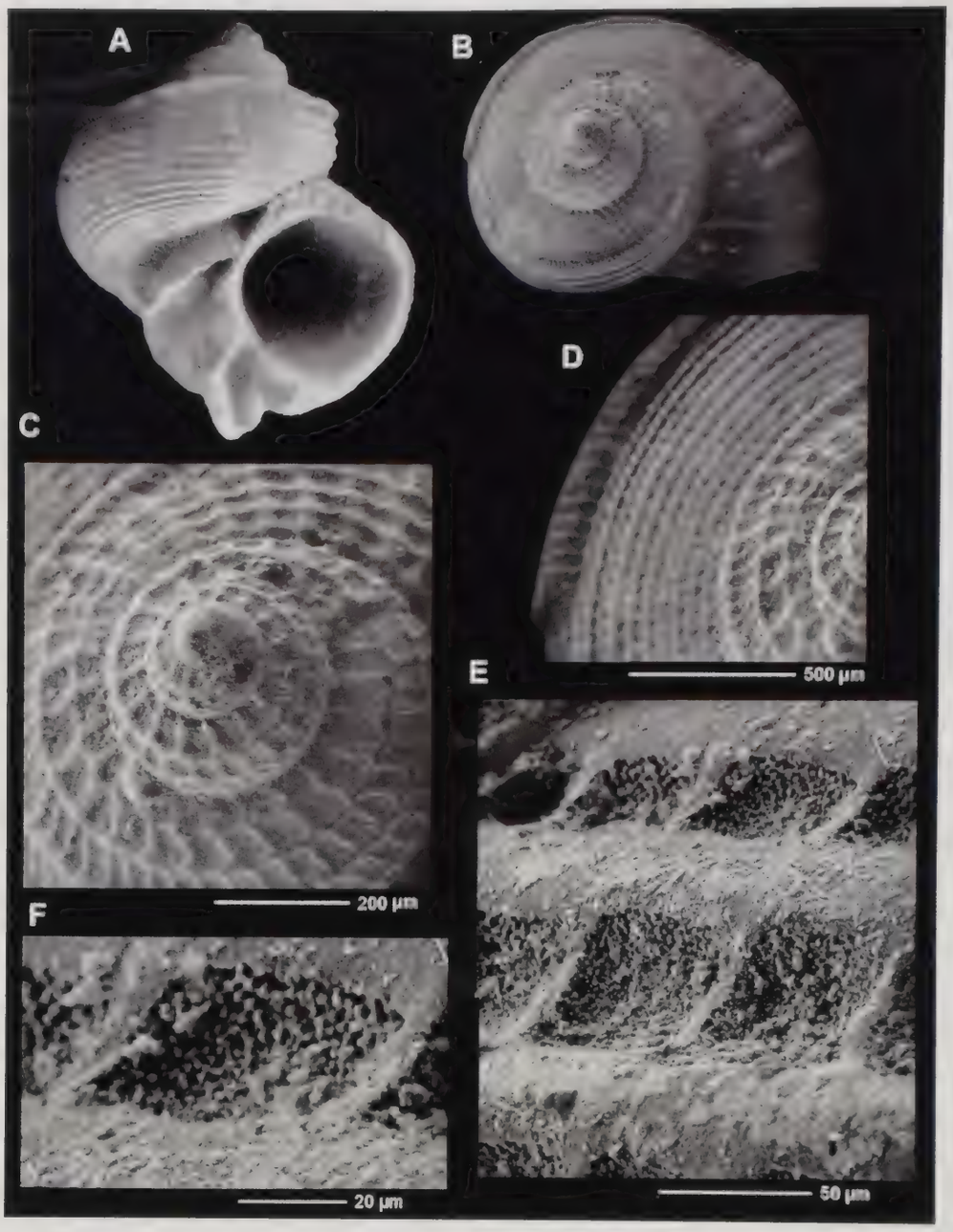

Figure 3A-F
Crosseola inverta (Hedley, 1907). A-B. Shell, 3.61 mm, S New Caledonia, 22°44'S-167°17'E, 350-393 m (MNHN); C. Apex and protoconch; D-F. Sculpture and detail.

without forming angles with the rounded periphery of the teleoconch. In apertural view there can be seen 3 spiral cords at the first and second whorls, 2 at the third, and 7 on the last one, where a broad subsutural region lacks spiral cords. There are no variciform axial thickenings.
A periumbilical cord, scarcely prominent and formed by small nodules due to the crossing of the axial ribs, borders and delimits the umbilicus.
The umbilicus is reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, arched, not reflected towards the umbilicus, with an anterior channel at the base. Outer lip scalloped internally with external margin not thickened or variciform.
Dimensions: The holotype is 4.65 mm in height and 4.27 mm in diameter (H/D = 1.1).

Habitat. Bathyal species dredged at 248-257 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola delicata* n. sp. is characterized by a regular sculpture, with a regular reticle without nodules in the intersection points, a scarcely prominent periumbilical cord and an umbilicus reduced to a fissure.

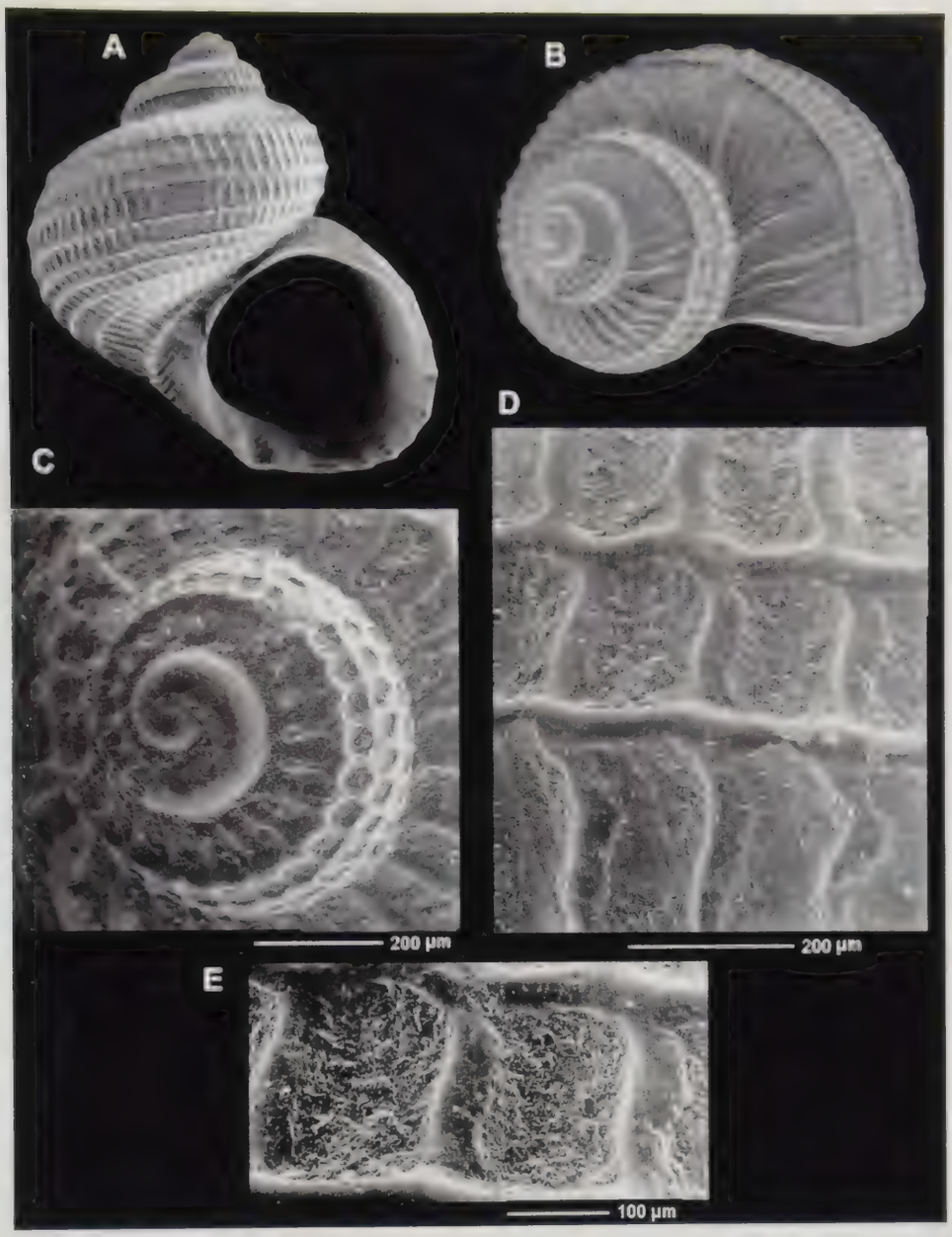

Figure 4A-E
Crosseola delicata n. sp. A. Holotype MNHN-IM-2000-34417, 4.65 mm in height, NE coast Taiwan, off Tashi 248-257 m; B. Paratype MNHN-IM-2000-34418, 4.54 mm, same locality; C. Protoconch of the paratype; D-E. Sculpture and detail.

Crosseola foveolata (Barnard, 1963) has more numerous axial ribs and spiral cords, with the rectangles very small.
See differences in remarks of *Crosseola latumlabrum* n. sp., *C. prosoclina* n. sp., *C. sexlata* n. sp., *C. minireticula* n. sp. and *C. occlusa* n. sp.

Etymology. The specific name alludes to the small and uniform sculpture of the shell, from the Latin *delicatus, a, um "delicate"*.

Crosseola mayottensis n. sp.
Fig. 5A-F

Type material. Holotype MNHN-IM-2000-34419 (Fig. 5A) and 2 paratypes MNHN-IM-2000-34420 (Fig. 5B).

Type locality. Mayotte, NE Récif Nord, 12°30'S-45°02'E, 450 m (BENTHEDI: stn DS71).

Material examined. BENTHEDI, stn DS71, 3 s, Mozambique Channel, Mayotte, NE Récif Nord, 12°30'S-45°02'E, 450 m.

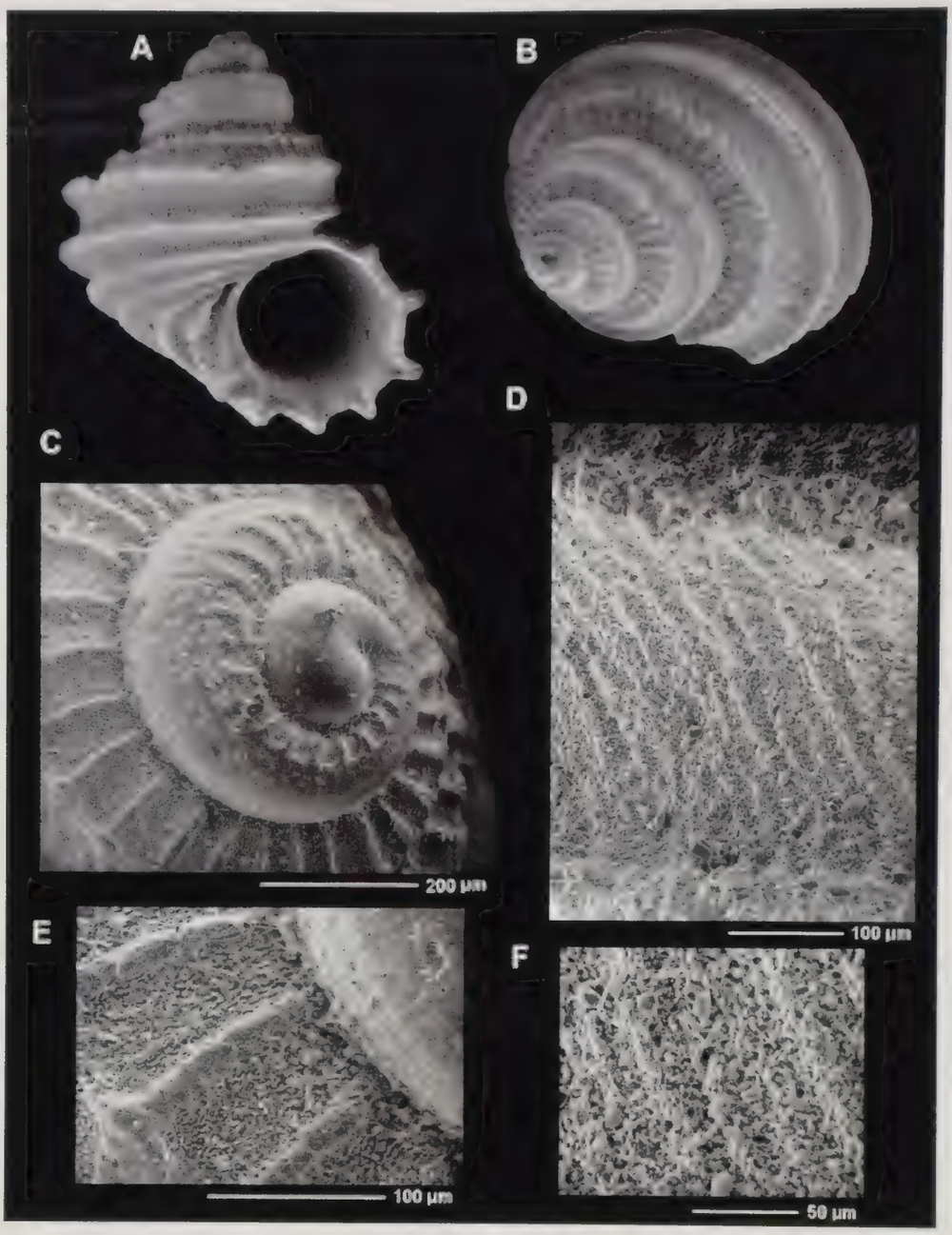

Figure 5A-F
Crosseola mayottensis n. sp., A. Holotype MNHN-IM-2000-34419, 2.43 mm in height, Mayotte, NE Récif Nord, 12°30'S-45°02'E, 450 m; B. Paratype MNHN-IM-2000-34420, 2.42 in diameter, same locality; C. Protoconch of the paratype; D-F. Sculpture and detail.

Description. Shell of small size (<3.0 mm), robust, turbiniform, with a high spire formed by about 4 whorls separated by a wide and deep suture, carinated and narrowly umbilicated.

The protoconch is formed by ¾ of a whorl, with a smooth surface and has an approximate size of 200 µm in diameter.

Teleoconch formed by about 3.4 whorls. Ornamentation formed by prominent spiral cords (carinae), axial ribs and microgranules. The spiral cords are prominent and angulate the periphery; in apertural view there can be seen 2 spiral cords at the first whorl, 3 at the second and 6 carinae on the last one, of which one is subsutural, 3 peripheral and 2 basal. There are no intermediate spiral cords. The spaces between carinae are very concave.

Axial ribs cross the spiral cords forming nodules on the intersection points, more evident in the subsutural cord. In the first two whorls the axial ribs cross the spiral cords forming a regular reticle of quadrangular/rectangular spaces; adapically, the axial riblets are thick and spaced between the subsutural cord and the suture, while they become more

numerous and tight towards the last whorl. Microgranules cover the entire teleoconch surface.
A prominent periumbilical cord, formed by successive fine axial ridges, borders and delimits the umbilicus, forming a keel. Umbilicus reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, straight, reflected basally towards the umbilicus, with an anterior channel at the base. Outer lip with scalloped margin, modified by the spiral carinae; external margin not thickened or variciform. The soft parts are unknown.
Dimensions: The holotype is 2.43 mm in height, and 2.24 mm in diameter (H/D = 1.08). There is a paratype of larger dimensions but with the protoconch broken.

Habitat. Bathyal species dredged at 450 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola mayottensis* n. sp. is characterized by its strong carinae; by its finely nodular subsutural cord and by the axial ribs which are transformed in the last whorls into thin and very tight axial threads.
See remarks under *C. bicarinata* n. sp., *C. anodyna* n. sp., *C. serrata* n. sp., *C. indigaxial* n. sp. and *C. uniformis* n. sp.

Etymology. The specific name refers to the type locality.

Crosseola microstriata n. sp.
Fig. 6A-F

Type material. Holotype MNHN-IM-2000-34421 (Fig. 6A-B).

Type locality. Fiji, S Viti Levu, 18°19'S-°78°05'E, 234-361 m (MUSORSTOM 10: stn CP1390).

Material examined. MUSORSTOM 10, stn CP1390, 1 s, Fiji, S Viti Levu, 18°19'S-°78°05'E, 234-361 m.

Description. Shell of small size (<3.0 mm), robust, turbiniform, with a high spire formed by 4.6 whorls separated by a wide suture, not carinated and narrowly umbilicated.
Protoconch with ¾ of a whorl, with a smooth surface and an approximate size of 220 µm in diameter.
The teleoconch is formed by 3 ¾ whorls and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow and cover the entire surface of the teleoconch.
The axial ribs cross the spiral cords forming nodules on the intersection points, more evident in the subsutural cord.
In the first whorl, the axial ribs crossing the spiral cords form a regular reticle of rectangular/quadrangular spaces; towards the last whorl where the axial sculpture disappear. The interspaces are covered by microgranules.
A prominent periumbilical cord, formed by fine spiral cords on its inner side and small oblique ribs on its outer side, borders and delimits the umbilicus forming a funicle. Umbilicus narrow, deep, and placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thick and reflected basally towards the umbilicus, with an anterior channel at the base. Outer lip with a smooth internal margin and extended to outside; the external margin is thickened or variciform, with three consecutive axial layers. The soft parts are unknown.
Dimensions: The holotype is 2.6 mm in height and 2.77 mm in diameter (H/D = 0.94)

Habitat. Bathyal species dredged at 234-361 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola microstriata* n. sp. is characterized by its very convex periphery and by lacking carinae; the surface of the teleoconch is completely covered by spiral cords with microgranules in their intervals; it is also characterized by the ornamentation of its periumbilical cord and by the ornamentation of its outer lip.
Its peculiar traits make it differ drastically from the rest of congeneric species.

Etymology. The specific name alludes to the very fine spiral microsculpture.

Crosseola latumlabrum n. sp.
Figs 7A-F, 8A-E

Type material. Holotype MNHN-IM-2000-34422 (Fig. 7A-B) and one paratype MNHN-IM-2000-34423 (Fig. 8A-B).

Type locality. Papua New Guinea, Solomon Sea, Ainto Bay, SE New Britain, 06°05'S-149°18'E, 240-250 m. (MADEEP, stn CP4335).

Material examined. MADEEP, stn CP4335, 2 s, Papua New Guinea, Solomon Sea, Ainto Bay, SE New Britain, 06°05'S-149°18'E, 240-250 m, (type material).

Description. Shell of small size (<2.50 mm), turbinate, with a high spire formed by 4.1 whorls separated by a marked suture, slightly carinated and narrowly umbilicated.
The protoconch is formed by ¾ of a whorl, with a smooth surface and has a size of about 240 µm in diameter.
The teleoconch has 3 whorls and its periphery is rounded and slightly carinated. Ornamentation formed by spiral cords, axial ribs and microgranules. Cords

Figure 6A-F
Crosseola microstriata n. sp. A-B. Holotype MNHN-IM-2000-34421, 2.6 mm in height, Fiji, S Viti Levu, 18°19'S-178°05'E, 234-361 m; C. Protoconch and first teleoconch whorl; D-F. Sculpture and detail.

and ribs cover the entire surface of the teleoconch, forming a regular reticle of rectangular/quadrangular spaces and marked nodules at the points of intersection. The spaces between cords and ribs are covered by microgranules.

There is no predominance of axial or spiral ornamentation; only the spiral cords project slightly over the ribs, angulating the periphery of the shell. In apertural view, there can be seen 4-5 spiral cords at first and second whorls and 10 at the last. There are no variciform axial thickenings.

A periumbilical cord, very prominent, formed by thick oblique cords, borders and delimits the umbilicus which is reduced to a narrow fissure placed between the periumbilical cord and the columellar lip. Aperture oval, prosocline; columella thin, slightly arched, widened at its base and reflected towards the umbilicus, with an anterior channel at the base. Outer lip smooth internally with the external margin thickened or variciform.

Dimensions: The holotype is 2.26 mm in height and 1.79 in diameter (H/D = 1.26).

Habitat. Bathyal species dredged at 240-250 m deep.

Distribution. Only known from the type locality.

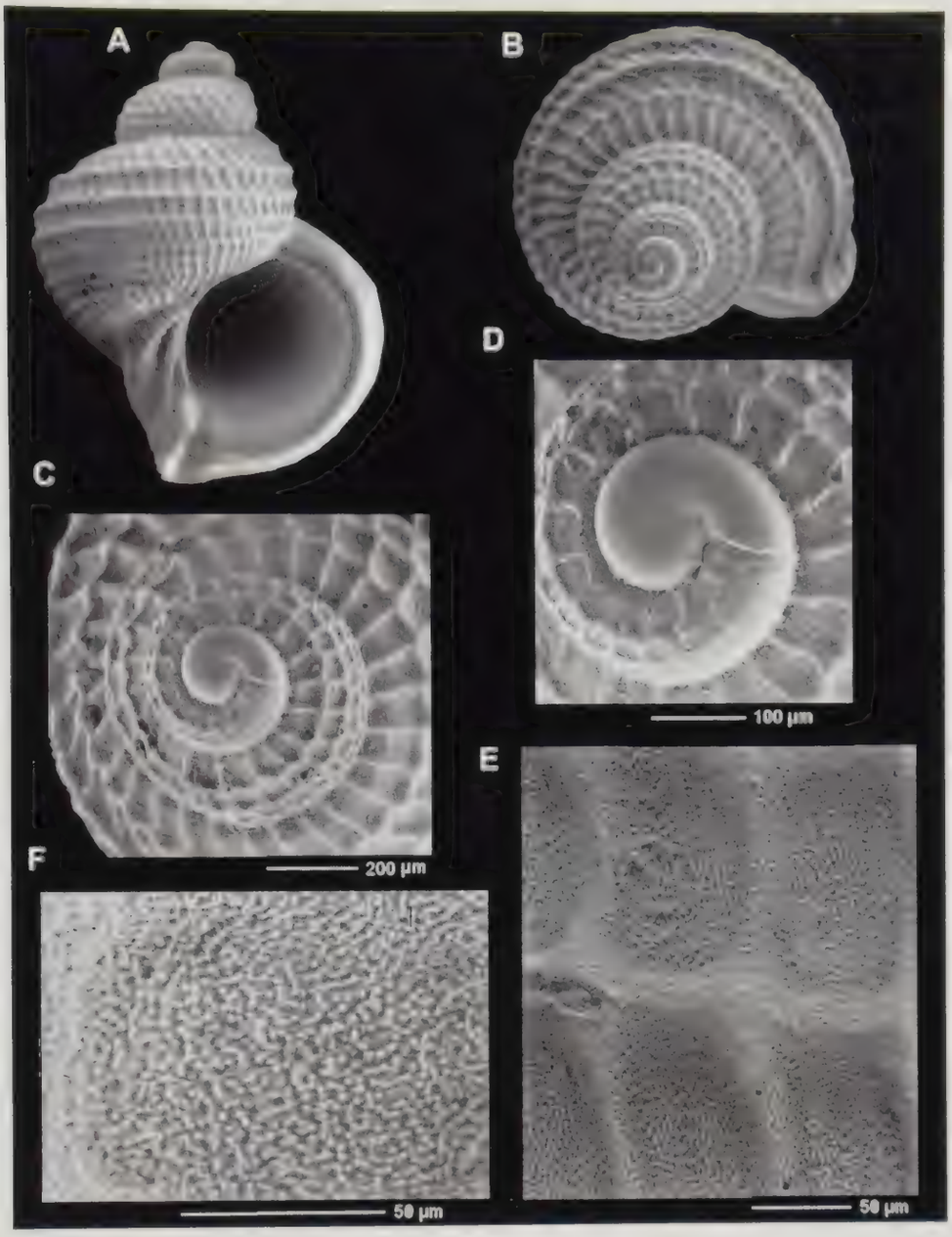

Figure 7A-F
Crosseola latumlabrum n. sp. A-B. Holotype MNHN-IM-2000-34422, 2.26 mm, Papua New Guinea, Solomon Sea, Ainto Bay, SE New Britain, 240-250 m; C-D. Apex and protoconch; E-F. Sculpture and detail.

Remarks. The paratype (Fig. 8A-B) in spite of being rather similar in a first view, has small differences with the holotype: the diameter of the protoconch is a little smaller (36 µm less than in the holotype); the outer lip is also different, although it is obvious that this is due to a difference in maturity; the paratype has some less spiral cords on the last whorl and its columella shape differs slightly as well. Having few material, we decided to provisionally include both specimens in the same taxa until more samples will be available.
There are no congeneric species which may be confused with *Crosseola latumlabrum*.

Etymology. The specific name alludes to the width of the external lip: from the Latin words *latus, a, um,* "wide" and *labrum, i,* "lip".

Crosseola distorta n. sp.
Fig. 9A-G

Type material. Holotype MNHN-IM-2000-34424 (Fig. 9A-B) and 3 paratypes MNHN-IM-2000-34425 (Figs 9C-D).

Type locality. Solomon Is, N Malaita, 8°19'S-160°40'E, 98-200 m (SALOMON 1: DW1767).

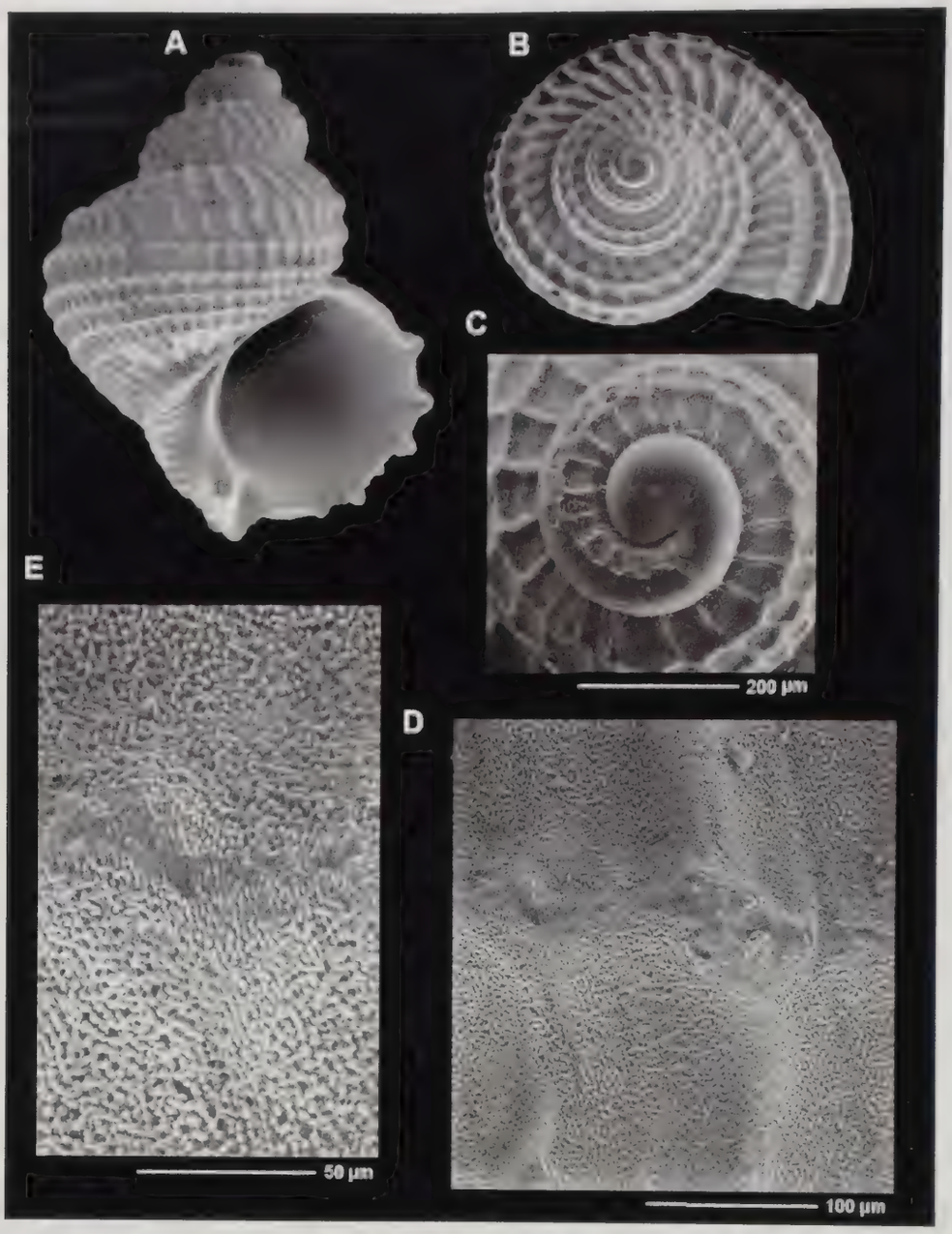

Figure 8A-E
Crosseola latumlabrum n. sp. A-B. Paratype MNHN-IM-2000-34423, 2.57 mm, Papua New Guinea, Solomon Sea, Ainto Bay, SE New Britain, 240-250 m; C. Apex and protoconch; D-E. Sculpture and detail.

Material examined. SALOMON 1, stn DW1767, 4 s, Solomon Is, 8°19'S-160°40'E, 98-200 m.

Description. Shell of small size (<3.5 mm), robust, turbiniform, with a high spire formed by 4.3 whorls separated by a wide suture, not carinated and the last whorl disjunct.
The protoconch is formed by a little less that 3/4 whorls, smooth surface and has an approximate size of 220 µm in diameter.
The teleoconch is formed by 3.5 whorls and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow and cover the entire surface of the teleoconch, except one broad subsutural area that starts at the second whorl and a periumbilical one which is visible at the base.
In the first two whorls the axial ribs crossing the spiral cords form a regular reticle of rectangular/quadrangular spaces; towards the last whorl, the spaces lengthen until they become progressively into narrow and shallow spiral grooves. The interspaces are covered by microgranules.
A prominent smooth cord borders and delimits the umbilical area; the umbilicus as such disappears because the last whorl is disjunct and is transformed into a concave area that extends between the cord and the columella.

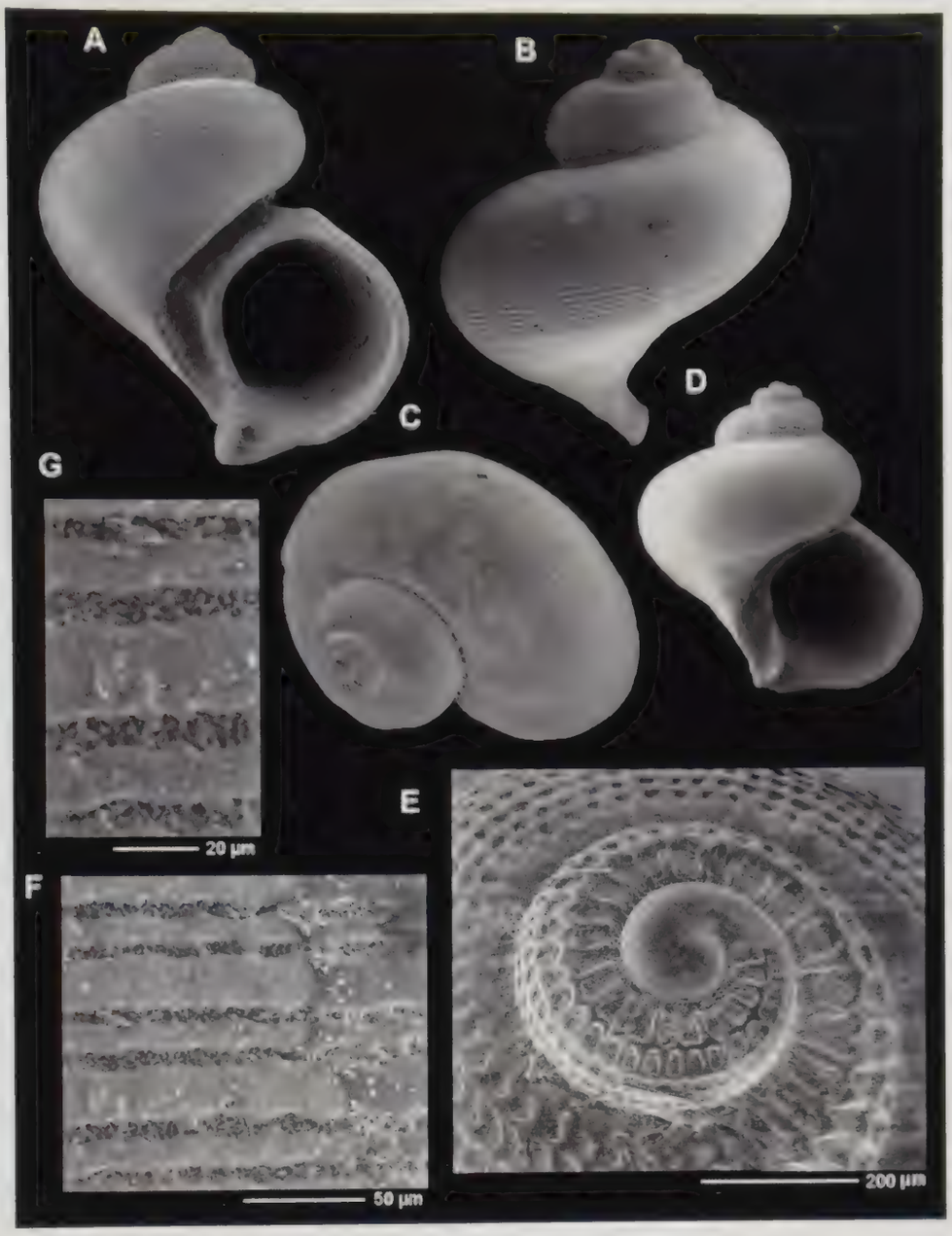

Figure 9A-G
Crosseola distorta n. sp. A-B. Holotype MNHN-IM-2000-34424, 3.05 mm in height, Solomon Is., Stn DW1767, 8°19'S-160°40'E, 98-200 m; C. Paratype MNHN-IM-2000-34425, 2.67 mm in diameter; D. Paratype MNHN-IM-2000-34425, juvenile, 2.21 in height (same locality); E. Protoconch and first teleoconch whorl; F. Detail of the sculpture.

Aperture rounded, prosocline; columella thick, not reflected towards the umbilicus, with a prominent anterior channel at the base. Outer lip with the internal margin finely crenulated; the external margin is not thickened or variciform.
Dimensions: The holotype is 3.05 mm in height and 2.57 mm in diameter (H/D = 1.18).

Habitat. Circalittoral to bathyal species dredged at 98-200 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola distorta* n. sp. is characterized by the separation of the last whorl from the previous one. This is not a malformation because in the paratypes (more juvenile) it is already possible to see that the last whorl is clearly separated.
There is no other species having this character which can be compared with *Crosseola distorta*.

Etymology. The specific name alludes to the unusual form of the holotype from the Latin *distortus, a, um* which means "misshapen" or "deformed".

Crosseola catenata n. sp.
Fig. 10A-F

Type material. Holotype MNHN-IM-2000-34426 (Fig. 10A-B).

Type locality. Philippines, SW Mindoro, 12°31.3'N-120°39.5'E, 92-97 m (MUSORSTOM 3: DR117).

Material examined. MUSORSTOM 3, stn DR117, Philippines, 1 s, 12°31.3'N-120°39.5'E, 92-97 m (holotype).

Description. Shell of very small size (<2.5 mm), robust, turbiniform, formed by 3.8 whorls separated by a marked suture, carinated and narrowly umbilicated.
The protoconch is formed by 0.8 whorls, with a smooth surface and has an approximate size of 224 µm in diameter.
The teleoconch is formed by 3 whorls and is carinated. The ornamentation is formed by prominent spiral cords (carinae), spiral threads, axial ribs and microgranules. After the first whorl, the subsutural cord disappears, while the peripheral ones persist. The spiral cords are prominent and angulate at periphery; in apertural view there can be seen 3 spiral cords at the first and second whorls and 6-7 carinae at the last one, of which 5 are peripheral and 1-2 are basal. There are intermediate spiral threads, which are distributed as following: 10 between the suture and the first peripheral carina and 1-2 between the lower peripheral carina and the basal cord; both the intermediate and basal cords are nodular. The spaces between carinae are strongly concave.
Axial ribs cross the spiral cords forming sharp-pointed nodules on the intersection points, which are more evident in the last whorl carinae, and a regular reticle of quadrangular/rectangular spaces. On the last whorl, the spiral cords are transformed into sharp carinae, the peripheral ones being the most prominent. All the carinae show in the last whorl, on either side of the margin, small ribs perpendicular to the axis of the shell.
Microgranules cover the entire teleoconch surface, including cords and ribs.
A prominent periumbilical cord, formed by successive thick nodules and cords on its inner side, skirts and delimits the umbilicus, which is reduced to a narrow fissure, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, straight, reflected basally towards the umbilicus, with an anterior channel at the base. Outer lip with margin strongly scalloped, modified by the spiral carinae; external margin not thickened or variciform.
Dimensions: The holotype is 2.11 mm in height and 1.8 mm in diameter (H/D = 1.17).

Habitat. Circalittoral species dredged at 92-97 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola catenata* n. sp. is characterized by the disappearance of the subsutural cord after the first whorl of the teleoconch; by the presence of intermediate spiral threads and sharp-pointed nodules on the intersection points; by the number of peripheral carinae and by the small axial microriblets perpendicular to the peripheral cord on the last whorl.
Crosseola latumlabrum n. sp. has more numerous and finer axial ribs and spiral cords, and a more prominent subsutural carina. The upper carina has no axial microriblets.
Crosseola dentata n. sp. has a narrower periumbilical cord, smaller aperture, and the crenulations in the outer lip are larger and more regular.

Etymology. The specific name alludes to the presence of an upper spiral cord on the last whorl with the aspect of a "chain" (in Latin *catena-ae*) (see Fig. 10E).

Crosseola dentata n. sp.
Fig. 11A-E

Type material. Holotype MNHN-IM-2000-34427 (Fig. 11A-B).

Type locality. Philippines, Bohol Seas, off Balicasag Island, 9°32'N-123°44'E, 164-176 m (PANGLAO 2005: stn DW2339).

Material examined. PANGLAO 2005, stn DW2339, 1 s, Philippines, Bohol Seas, off Balicasag Island, 9°32'N-123°44'E, 164-176 m.

Description. Shell of very small size (<2.5 mm), robust, turbiniform, formed by 3 ¾ whorls separated by a marked suture, carinated and narrowly umbilicated.
The protoconch is formed by 0.6 whorls with a smooth surface and has an approximate size of 205 µm in diameter.
The teleoconch is formed by 3.3 whorls and is carinated; the spaces between carinae are very concave.
The ornamentation is formed by prominent spiral cords (carinae), axial ribs and microgranules. The spiral cords are prominent and angulate the periphery; in apertural view there can be seen 4 spiral cords at the first and second whorls and 5 carinae at the last one, of which 4 are peripheral and 1 is basal. There are no intermediate spiral threads.
Axial ribs cross the spiral cords forming pointed nodules on the intersection points, more evident in the last whorl carinae and also forming a regular reticle of quadrangular/rectangular spaces. On the last whorl,

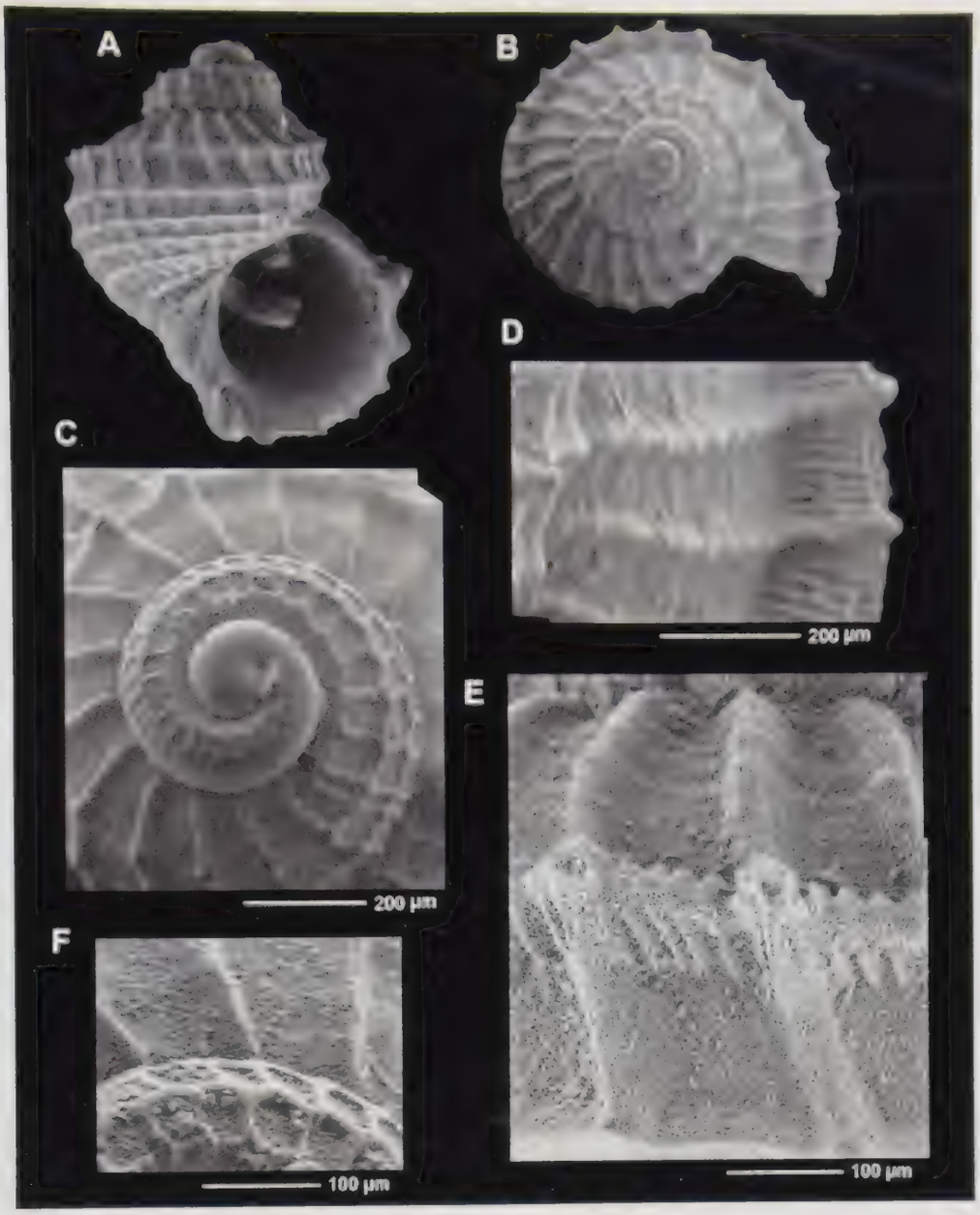

Figure 10A-F
Crosseola catenata n. sp. A-B. Holotype MNHN-IM-2000-34426, 2.11 mm, Philippines, Stn DR117, 12°31.3'N-120°39.5'E, 92-97 m; C. Protoconch and first teleoconch whorl; D-F. Detail of the sculpture.

the spiral cords are transformed into sharp carinae of which the peripherals are the most prominent.
In the last whorl and a half, the subsutural cord disappears forming a larger, convex space between the suture and the first peripheral carina, which is occupied by numerous and high axial ribs. Microgranules cover the entire teleoconch surface, including cords and ribs.
A prominent periumbilical cord formed by successive thick lamellae skirts and delimits the umbilicus, which is narrow and is placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, arched and reflected basally towards the umbilicus, with an anterior channel at the base. Outer lip with margin strongly scalloped and modified by the spiral carinae; external margin not thickened or variciform.
Dimensions: The holotype is 2.1 mm in height and 1.74 in diameter (H/D = 1.2).

Habitat. Bathyal species dredged at 164-176 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola dentata* n. sp. is characterized by the strong teeth on the outer lip, which provide it with a saw-like shape.
Crosseola anodyna n. sp. has a similar form, but the number of the axial ribs are smaller (in last whorl 29 vs 36 in *C. dentata*); also the protoconch is slightly

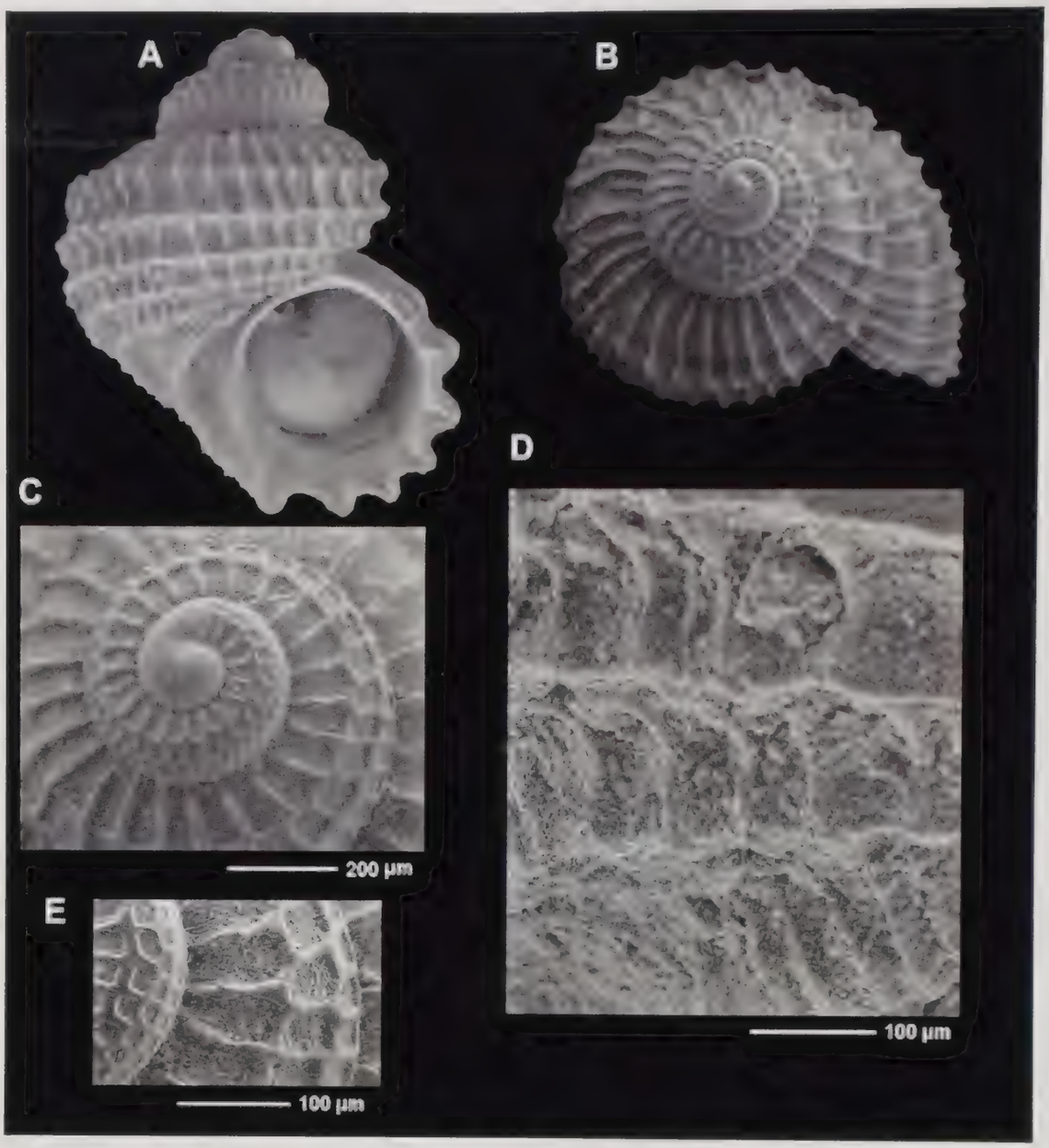

Figure 11A-E
Crosseola dentata n. sp. A-B. Holotype MNHN-IM-2000-34427, 2.1 mm, Philippines, Bohol Seas, off Balicasag Island, 164-176 m; C. Protoconch and first teleoconch whorl; D-E. Detail of the sculpture

larger (205 µm, vs 235) and the the prominences are smaller within the outer lip.
See also remarks under *C. catenata* n. sp.

Etymology. The specific name alludes to the outer lip which has prominent teeth, from the Latin *dentatus, a, um* "with teeth".

Crosseola anodyna n. sp.
Fig. 12A-D

Type material. Holotype MNHN-IM-2000-34428 (Fig. 12A).

Type locality. Philippines, Bohol/Sulu Seas sill, 9°01'N-123°26'E, 427 m (PANGLAO 2005: DW2364).

Material examined. PANGLAO 2005, stn DW2364, 1 s, Philippines, Bohol/Sulu Seas sill, 09°01'N-123°26'E, 427 m (holotype).

Description. Shell of very small size (<2.5 mm), robust, turbiniform, formed by 3.8 whorls separated by a marked suture, with whorls, carinated and narrowly umbilicated.
The protoconch is formed by ¾ of a whorl, with a smooth surface and has a size of 235 µm in diameter.

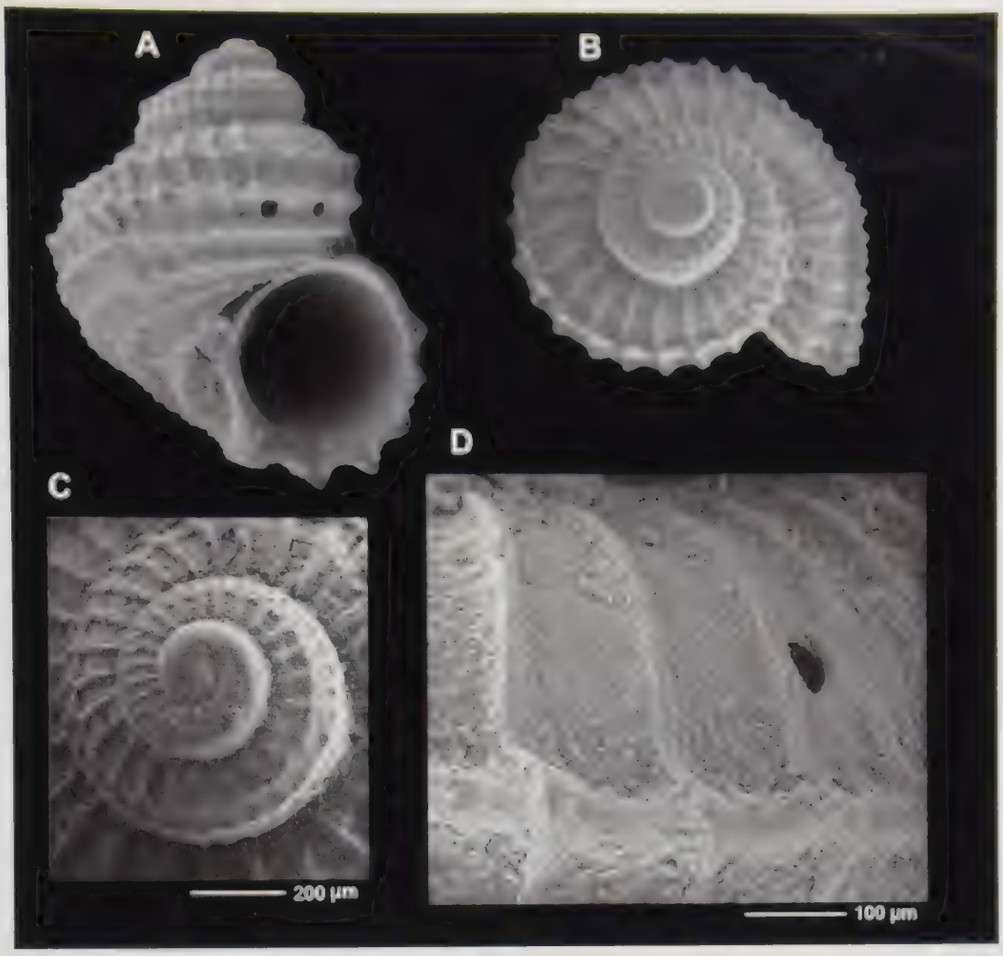

Figure 12A-D
Crosseola anodyna n. sp. A-B. Holotype MNHN-IM-2000-34428, 2.25 mm in height, Philippines, Bohol/Sulu Seas sill, 9°01'N-123°26'E, 427 m; C. Protoconch; D. Microsculpture.

The teleoconch is formed by little more that 3 whorls and is carinated; the spaces between carinae are very concave.

Prominent spiral cords (carinae) define the ornamentation together with axial ribs and microgranules. The spiral cords are prominent and angulate the periphery; in apertural view 4 spiral cords can be seen at the first whorl, 3 at the second and 5 carinae at the last one, of which 4 are peripheral and 1 is basal. There are no intermediate spiral threads. The basal carina is very similar to the periumbilical cord.

Axial ribs cross the spiral cords forming pointed nodules on the intersection points, which are more evident on the last whorl carinae and form a regular reticle of quadrangular/rectangular spaces. On the last whorl, the spiral cords are transformed into sharp carinae, the peripheral ones being the most prominent.

In the last whorl, the subsutural cord disappears forming a broad convex interval between the suture and the first peripheral carina, which is occupied by numerous long axial ribs. Microgranules cover the entire teleoconch surface, including cords and ribs.

A prominent periumbilical cord crossed by numerous axial ribs skirts and delimits the umbilicus, which is narrow and is placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thick, arched and reflected basally towards the umbilicus, with an anterior channel at the base. Outer lip with margin strongly scalloped and modified by the spiral carinae; external margin not thickened or variciform.

Dimensions: The holotype is 2.25 mm in height and 1.82 mm in diameter (H/D = 1.24).

Habitat. Bathyal species dredged at 427 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola anodyna* n. sp. is characterized by a regular sculpture and a narrow periumbilical cord.

Crosseola mayottensis n. sp. has wider and more prominent carinae and a much finer axial sculpture.

Crosseola serrata n. sp. has very fine short axial riblets in the carinae, very obvious in the last two whorls in perpendicular sense, which are not present in *C. anodyne* n. sp., which has a small number of axial ribs.

See also remarks under *C. dentata* n. sp.

Etymology. The specific name alludes to the fact that this species has scarce differential characteristics, from the Latin *anodynus* which means "anodyne, insignificant and/or simple".

Crosseola serrata Rubio, Rolán & Gori n. sp.
Fig. 13A-F

Type material. Holotype MNHN-IM-2000-34429 (Fig. 13A-B).

Type locality. Mozambique, Narenque, Fernando Veloso, 14°26.9'S-40°40.7'E, 38 m.

Material examined. Mozambique, 1 s, Narenque, Fernando Veloso, 14°26.9'S-40°40.7'E, 38 m (holotype, ex CSG).

Description. Shell of small-size (<4.5 mm), robust, turbiniform, formed by about 5 whorls, separated by a marked suture, carinated and narrowly umbilicated.
The protoconch is formed by 0.8 whorls, with a smooth surface and is about 260 µm in diameter.
The teleoconch is formed by about 4.5 whorls; with an ornamentation composed of thick spiral cords (carinae), spiral threads, axial ribs, axial riblets and microgranules. The spiral cords (carinae) are prominent and angulate the periphery; in apertural view there can be seen 3 spiral cords at the first whorl, 2 carinae at the second and third and 6 carinae on the last one, of which 4 are peripheral and 2 are basal. On the last whorl, about 20 intermediate spiral cordlets are distributed as follows: 12 between the suture and the first peripheral carina and 4-8 between each of the remaining carinae. The spaces between carinae are very concave. Axial ribs cross the interspaces forming a regular reticle of quadrangular/rectangular spaces. All the carinae present in the two last whorls, have on either side of the edge, small riblets perpendicular to the carinae in the sense of the axis of the shell. Microgranules cover the entire teleoconch surface, including cords and ribs.
A prominent periumbilical cord formed by successive spiral cords, including its inner side, skirts and delimits the umbilicus, which is narrow, deep and is placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thin, straight and not reflected, with an anterior channel at the base. Outer lip with margin strongly scalloped and modified by the spiral carinae; external margin not thickened or variciform.
Dimensions: The holotype measures 4.41 mm in height and 4.04 mm in diameter (H/D = 1.09).

Habitat. Infralittoral species collected by diving at 38 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola serrata* n. sp. is characterized by its high spire, by its strong peripheral carinae with axial riblets on each side of the edge, by its intermediate spiral threads, by its narrow umbilicus and by the shape of the periumbilical cord.
Crosseola mayottensis n. sp. has more numerous and finer axial riblets between the spiral cords, and it lacks the very short ones that *Crosseola serrata* has on the carinae walls.

Etymology. The specific name alludes to the form of the spiral carinae that, because of their numerous small teeth, provide the shell with a saw-like shape.

Crosseola indigaxial Rubio, Rolán & Gori n. sp.
Fig. 14A-E

Type material. Holotype MNHN-IM-2000-34430 (Fig. 14A-B).

Type locality. Maldives, Guraidhoo Kandu, S Male Atoll, 03°54'N-73°28'E, 20 m, sand in small cave

Material examined. Maldives, 1 s, Guraidhoo Kandu, S Male Atoll, 03°54'N-73°28'E, 20 m, sand in small cave (holotype, ex CSG).

Description. Shell of small size (<4.0 mm), robust, turbiniform, formed by little more than 4.1 whorls, separated by a wide and deep suture, carinated and narrowly umbilicated.
The protoconch is formed by 0.8 whorls, with a smooth surface and is about 328 µm in diameter. The teleoconch is formed by about 3.3 whorls; with an ornamentation formed by thick spiral cords (carinae), spiral threads and axial ribs. The spiral cords (carinae) are prominent and angulate the periphery; in apertural view there can be seen 2 spiral cords at the first and second whorls and 6 carinae at the last one, of which 4 are peripheral and 2 are basal. Intermediate spiral cordlets can be found distributed in the last whorl: 9-10 between the suture and the first peripheral carina, and 4-6 between each of the remaining carinae excluding the basal ones. The spaces between carinae are very concave. Axial ribs cross the interspaces forming a regular reticle of quadrangular/rectangular spaces. On the last whorl, interspaces are covered by axial ribs and spiral cordlets, except in some sections where the axial ribs disappear and only the spiral cords are visible.
A periumbilical cord, formed by successive axial ribs, penetrates inside the umbilicus and delimits it. The umbilicus is narrow and deep, and is placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella thick, with a groove in its middle zone and an anterior channel at the base. Outer lip with inner margin strongly scalloped; external margin not thickened or variciform.

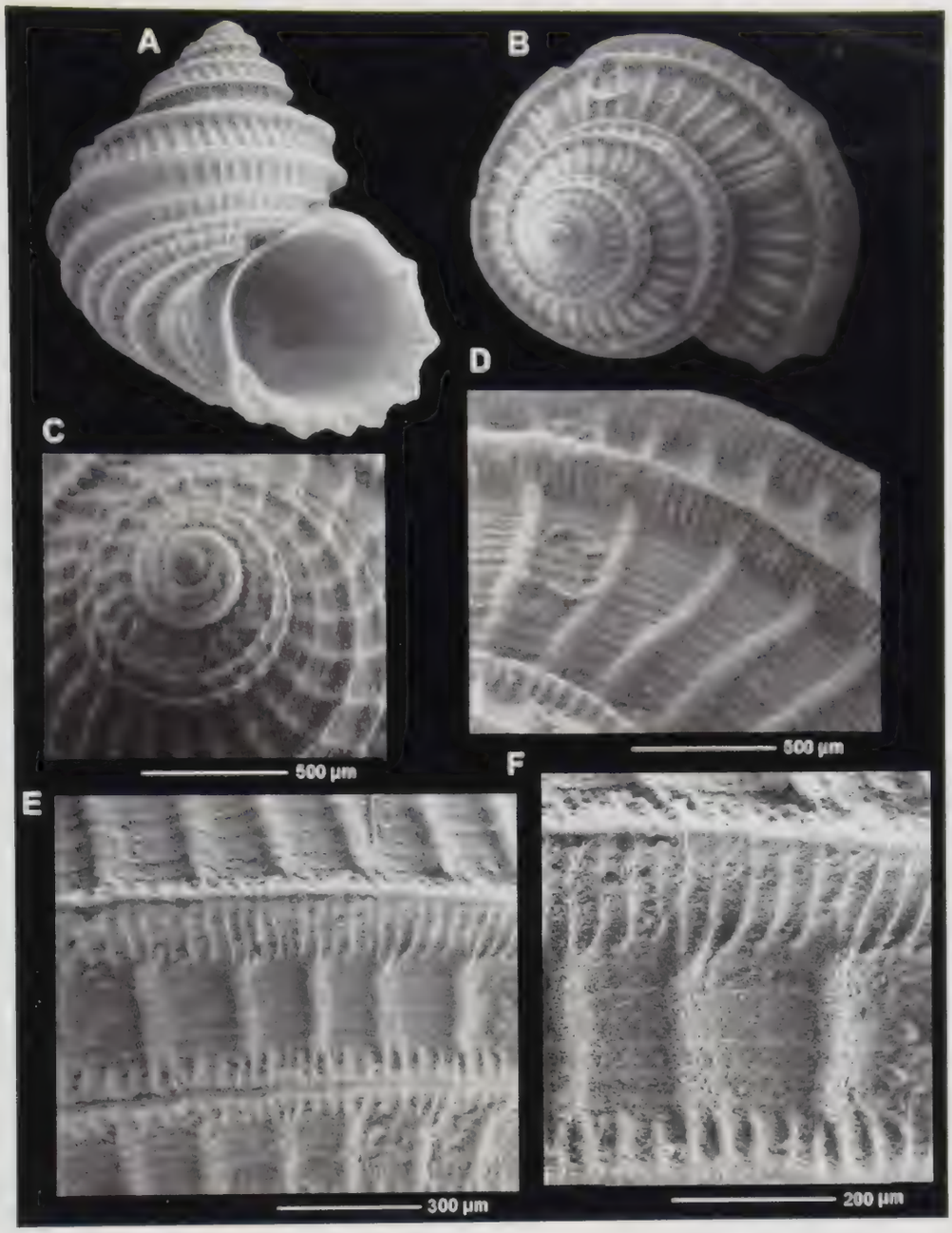

Figure 13A-F
Crosseola serrata n. sp. A-B. Holotype MNHN-IM-2000-34429, 4.41 mm, Mozambique, Narenque, Fernando Veloso, 14°26.9'S-40°40.7'E, 38 m; C. Protoconch and first teleoconch whorl; D-F. Sculpture and details.

Dimensions: The holotype is 3.64 in height and 3.36 mm in diameter (H/D = 1.08)

Habitat. Infralittoral species collected by diving at 20 m deep on sand in a small cave in rocky bottom.

Distribution. Only known from the type locality.

Remarks. *Crosseola indigaxial* n. sp. is characterized by having well delimited spiral cords which, except in the middle part, have axial ribs in between.
Crosseola serrata n. sp. has a similar profile but the axial cordlets are present in the periphery of the last whorl, the carinae are more prominent, and very small and dense microriblets cross its spiral sculpture.
Crosseola uniformis n. sp. (see below) is also rather similar but the axial riblets are present in the interspaces between the carinae and there is no continuous spiral sculpture between them.
Crosseola mayottensis n. sp. has wider and more prominent spiral carinae while the axial sculpture is much finer and tighter.

Etymology. The specific name is derived from the Latin words *axial* (referred to the axial sculpture) and *indigens* which means "those who lack", meaning that

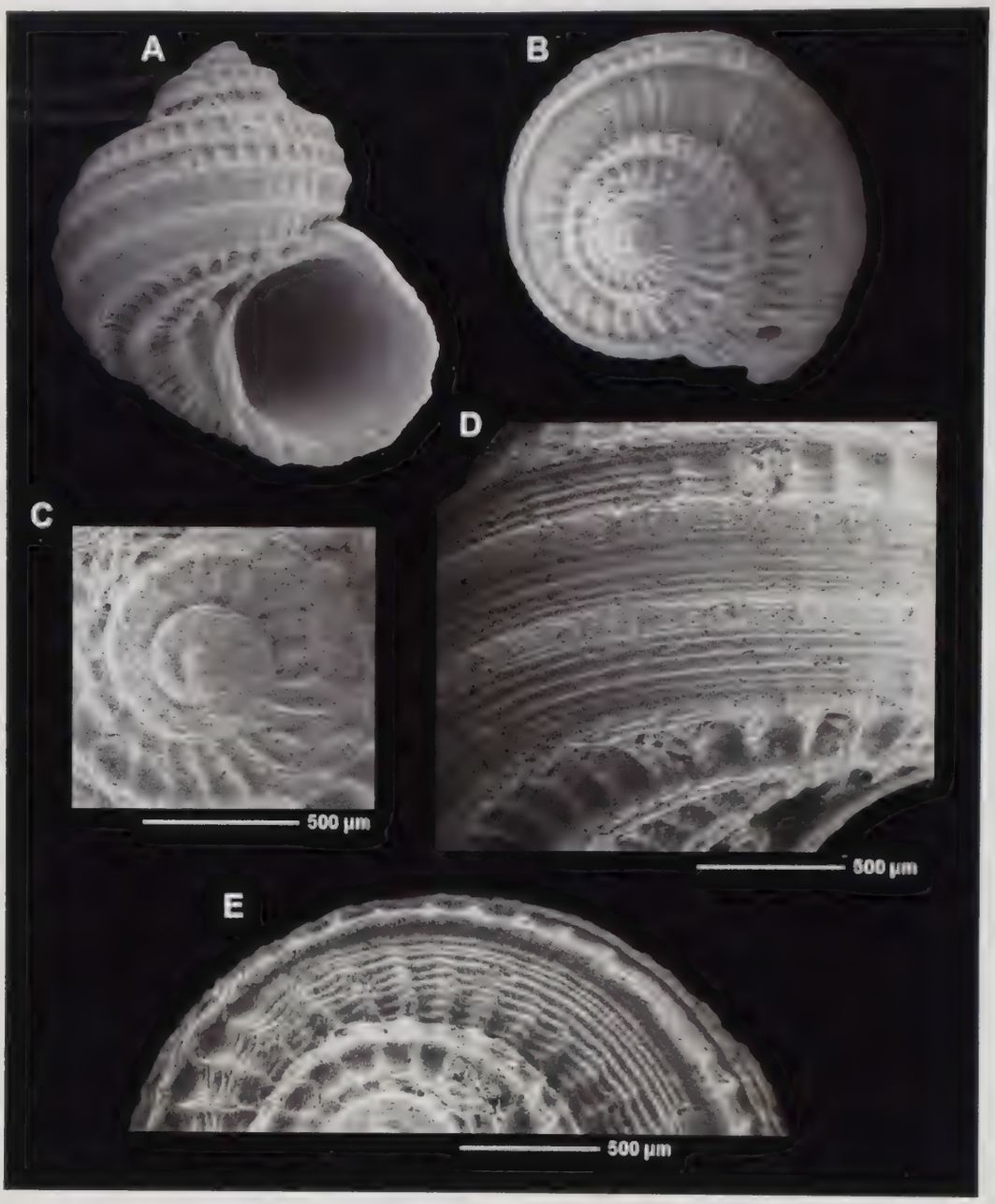

Figure 14A-E
Crosseola indigaxial n. sp. A-B. Holotype MNHN-IM-2000-34430, 3.64 mm in height, Maldivas, Guraidhoo Kandu, S Male Atoll, 03°54'N-73°28'E, 20 m; C. Protoconch and first teleoconch whorls; D-E. Detail of the sculpture.

in some spaces between the spiral cords, there is no axial sculpture.

Crosseola uniformis Rubio, Rolán & Gori n. sp.
Fig. 15A-E

Type material. Holotype MNHN-IM-2000-34431 (Fig. 15A-B).

Type locality. Maldives, Old Shark Point, Villingili, N Male Atoll, 30 m, sand in a small cave.

Material examined. Maldives, 1 s, Old Shark Point, Villingili, N Male Atoll, 30 m, sand in small cave (holotype, ex CSG).

Description. Shell of small size (<4.0 mm), robust, turbiniform, formed by slightly over 4.3 whorls, separated by a wide and deep suture, carinated and narrowly umbilicated.
The protoconch is formed by 0.8 whorls, with a smooth surface and is about 328 µm in diameter.
The teleoconch is formed by about 3.5 whorls: ornamentation comprising thick spiral cords (carinae), spiral cordlets, axial ribs and microgranules. The

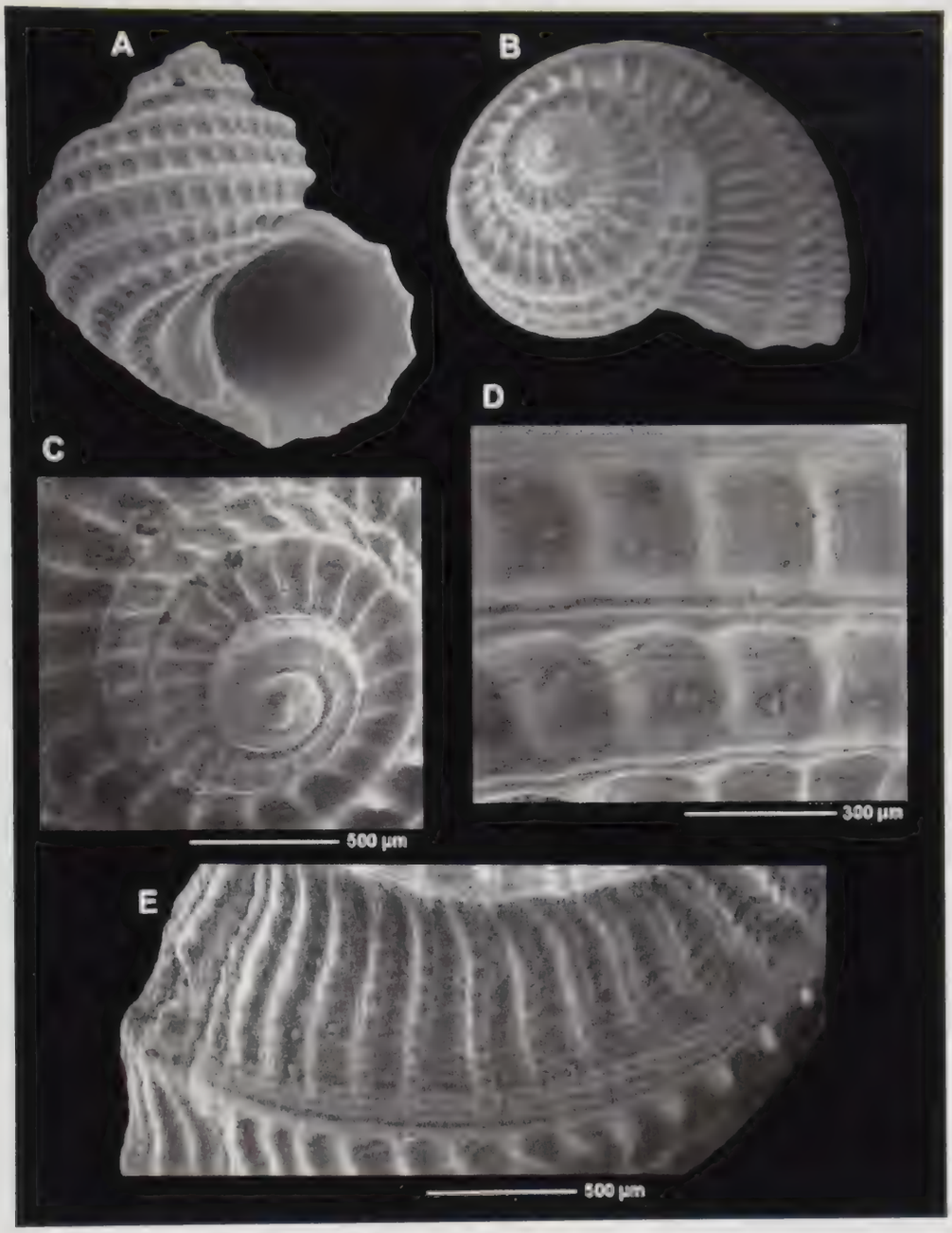

Figure 15A-E
Crosseola uniformis n. sp. A-B. Holotype MNHN-IM-2000-34431, 3.63 mm in height, Maldivas, Old Shark Point, Villingili, N Male Atoll, 30 m; C. Protoconch and first teleoconch whorl; D-E. Details of the sculpture.

spiral cords (carinae) are prominent and angle the periphery; in apertural view there are 2 spiral cords at the first and second whorls and 6 carinae at the last one, of which 4 are peripheral and 2 are basal. If we look at the edge of each carina, we see that it is formed by two very close cords with a narrow groove between them. There are intermediate spiral cordlets, which are distributed in the last whorl: there are 9-10 between the suture and the first peripheral carina while the ones placed between the remaining carinae are scarcely visible. The spaces between carinae are very concave.

Axial ribs cross the interspaces forming a regular reticle of quadrangular/rectangular spaces. In the last whorl, in the space between the suture and the first peripheral carina, the spiral cordlets cross the axial ribs forming small nodules in the intersection points. Microgranules cover the entire teleoconch surface.

The periumbilical cord is high and its nodular edge is formed by the successive axial ribs that cross it.

Umlilicus narrow and deep, placed between the periumbilical cord and the columellar lip. Aperture rounded, prosocline; columella very thick, with a groove in its middle zone and an anterior channel at its base. Outer lip with inner margin strongly scalloped; external margin not thickened or variciform.

Dimensions: The holotype is 3.63 mm in height and 3.4 mm in diameter (H/D = 1.06).

Habitat. Infralittoral species collected by diving at 30 m deep on sand in small cave.

Distribution. Only known from the type locality.

Remarks. *Crosseola uniformis* n. sp. is characterized by a regular axial and spiral sculpture, with very fine spiral cordlets which mount on tight axial ribs in the last whorl.
See Remarks of *Crosseola indigaxial* n. sp.
Crosseola mayottensis n. sp. has the spiral carinae wider and more prominent, while the axial sculpture is much finer and much tighter.

Etymology. The specific name is from the Latin word *uniformis, e* which means "regular" and alludes to the regularity of its sculpture.

Crosseola intercalaris n. sp.
Fig. 16A-F

Type material. Holotype MNHN-IM-2000-34432 (Fig. 16A) and 16 paratypes MNHN-IM-2000-34433 (Fig. 16B-C).

Type locality. S New Caledonia, 22°38'S-167°10'E, 124 m (BATHUS 2: DW714).

Material examined. BATHUS 2, stn DW714, 17 s, S New Caledonia, 22°38'S-167°10'E, 124 m (type material).

Description. Shell minute (<2.0 mm), robust, turbiniform, formed by 3.0 whorls, nodular and narrowly umbilicated.
The protoconch is formed by 0.7 whorls, with smooth surface and has a size of about 180 µm in diameter.
The teleoconch is formed by 2.5 whorls, and its periphery has an ornamentation formed by spiral cords, axial ribs and microgranules.
In apertural view there are 4 spiral cords at the first whorl and 7 at the last one; the cords on the first whorl are distributed in a zigzag pattern crossing the axial ribs, and forming a reticulate pattern of rectangular cells and small thickenings at the intersections; towards the anterior pole, the cords and ribs thicken progressively forming ever thicker nodules at the intersections and at the last whorl a regular reticle of quadrate spaces.
The entire shell surface is covered by microgranules that are aligned forming fine threads that occupy the interior of the cells of the reticle.
A prominent spiral ridge borders and delimits the umbilicus.
Aperture rounded, prosocline. Thickened parietal lip; columellar lip thick, arched and reflected towards the umbilicus. Thick outer lip; external margin modified by the spiral cords.
Dimensions: The holotype measures 1.68 mm in height and 1.57 in diameter (H/D = 1.07). The paratypes are more juvenile.

Habitat. Bathyal species dredged at 124 m depth.

Distribution. Only known from the type locality.

Remarks. *Crosseola intercalaris* n. sp. is characterized by the prominent sculpture more than any other studied in this genus.

Etymology. The specific name alludes to the crossing between the axial and spiral sculpture, from the Latin word *intercalaris, e* "intercalate".

Crosseola prosoclina n. sp.
Fig. 17A-F

Type material. Holotype MNHN-IM-2000-34434 (Fig. 17A).

Type locality. Vanuatu, 19°25'S-169°27'E, 160-182 m (MUSORSTOM 8: DW976).

Material examined. MUSORSTOM 8, stn DW976, 1 s, Vanuatu, 19°25'S-169°27'E, 160-182 m (holotype).

Description. Shell of small size (<4.0 mm), globose to turbinate, as high as wide, formed by 3.7 whorls separated by a marked suture; with a very convex periphery and narrowly umbilicated.
The protoconch is smooth, formed by about ¾ of whorl and with a size of 260 µm in diameter. The teleoconch is formed by 3.1 whorls and its periphery is rounded. Ornamentation formed by spiral cords, axial ribs and microgranules. In apertural view there are 3 spiral cords on the first and second whorls and 12-14 on the last one; the cords on the first whorl are distributed in a zigzag patterm crossing the axial ribs, and forming a reticulate pattern of regular shape and small thickenings at the intersections; towards the base, the axial ribs thicken progressively, raise separate widely from each other; the number of spiral cords increases, maintaining the same thickness as on the initial whorls but the nodules at the intersections with the axial ribs are smaller on the last whorl.
The entire shell surface is covered by microgranules.
A prominent, spiral ridge formed by successive axial folds, borders and delimits the umbilicus, forming a keel.
The umbilicus is limited to a deep cleft formed between the periumbilical cord and the columellar lip.
Aperture rounded, prosocline; columella thin, arched, reflected towards the umbilicus, with an anterior channel at the base. Outer lip sinuous; smooth edged, not modified by the spiral cords; external margin not thickened or variciform.

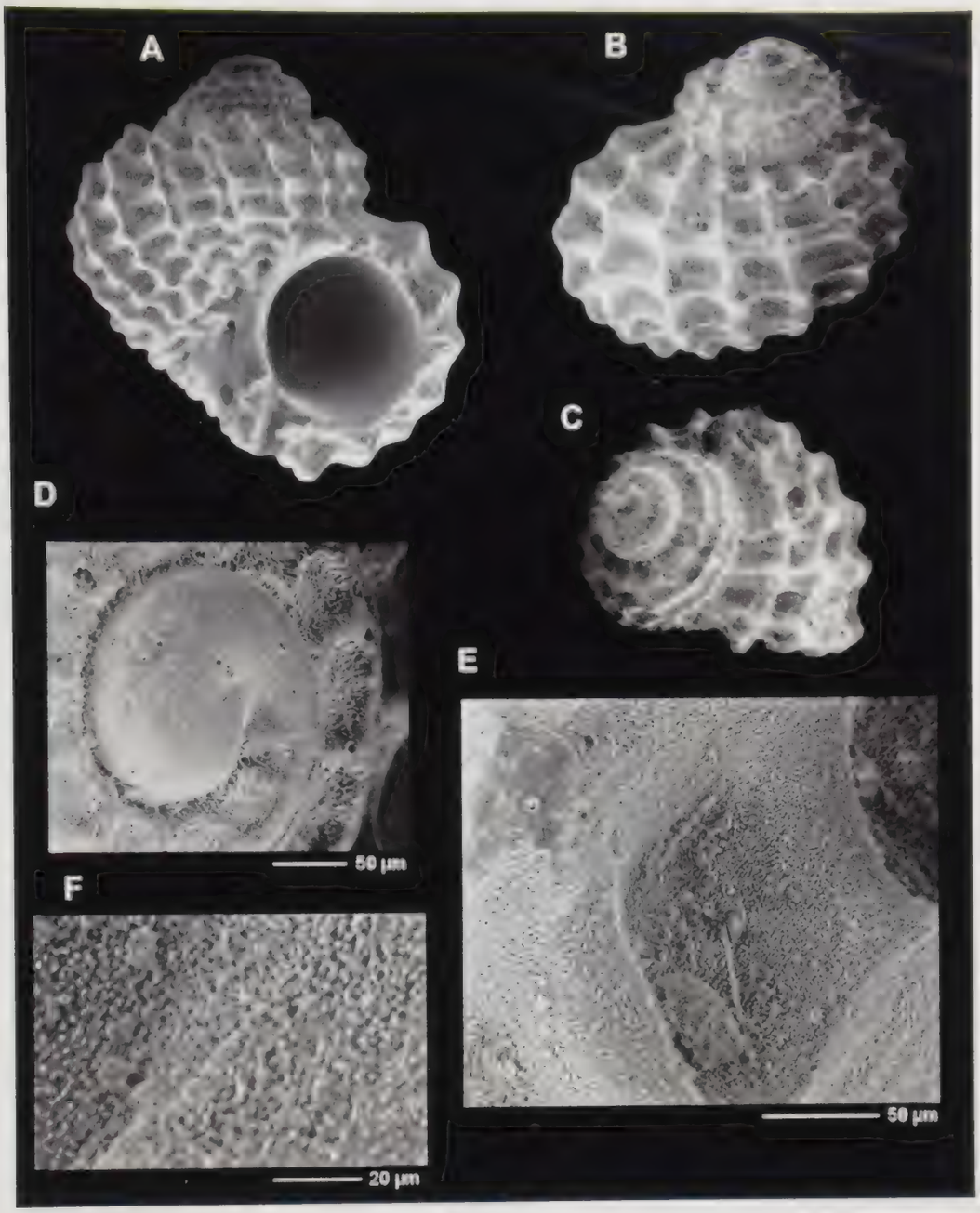

Figure 16A-F
Crosseola intercalaris n. sp. A. Holotype MNHN-IM-2000-34432, 1.68 mm in height, S New Caledonia, 22°38'S-167°10'E, 124 m; B-C. Paratypes MNHN-IM-2000-34433, 1.5 and 1.34 mm in diameter, same locality; D. Protoconch; E-F. Microsculpture and detail.

Dimensions: The holotype measures 3.97 mm in height and 3.74 mm in diameter.

Habitat. Bathyal species dredged at 160-182 m depth.

Distribution. Only known from the type locality.

Remarks. *Crosseola prosoclina* n. sp. is characterized by a regular sculpture with strongly prosocline axial ribs. The periumbilical cord is narrow and prominent, with elevations which are prologations of the axial ribs.

Crosseola delicata n. sp and *C. latumlabrum* n. sp. may seem to be similar, but their axial sculptures are formed by short riblets which are narrower than those of *C. prosoclina* n. sp.; furthermore they are not prosocline.

Crosseola dentata n. sp., *C. anodyna* n. sp., *C. uniformis* n. sp. and *C. serrata* n. sp have a clear predominance of spiral carinae over the axial sculpture.

Crosseola sexlata n. sp. has also prosocline axial ribs, but in smaller quantity, the periumbilical cord is evidently much wider, the outer lip is very thickened and the base more prolongated.

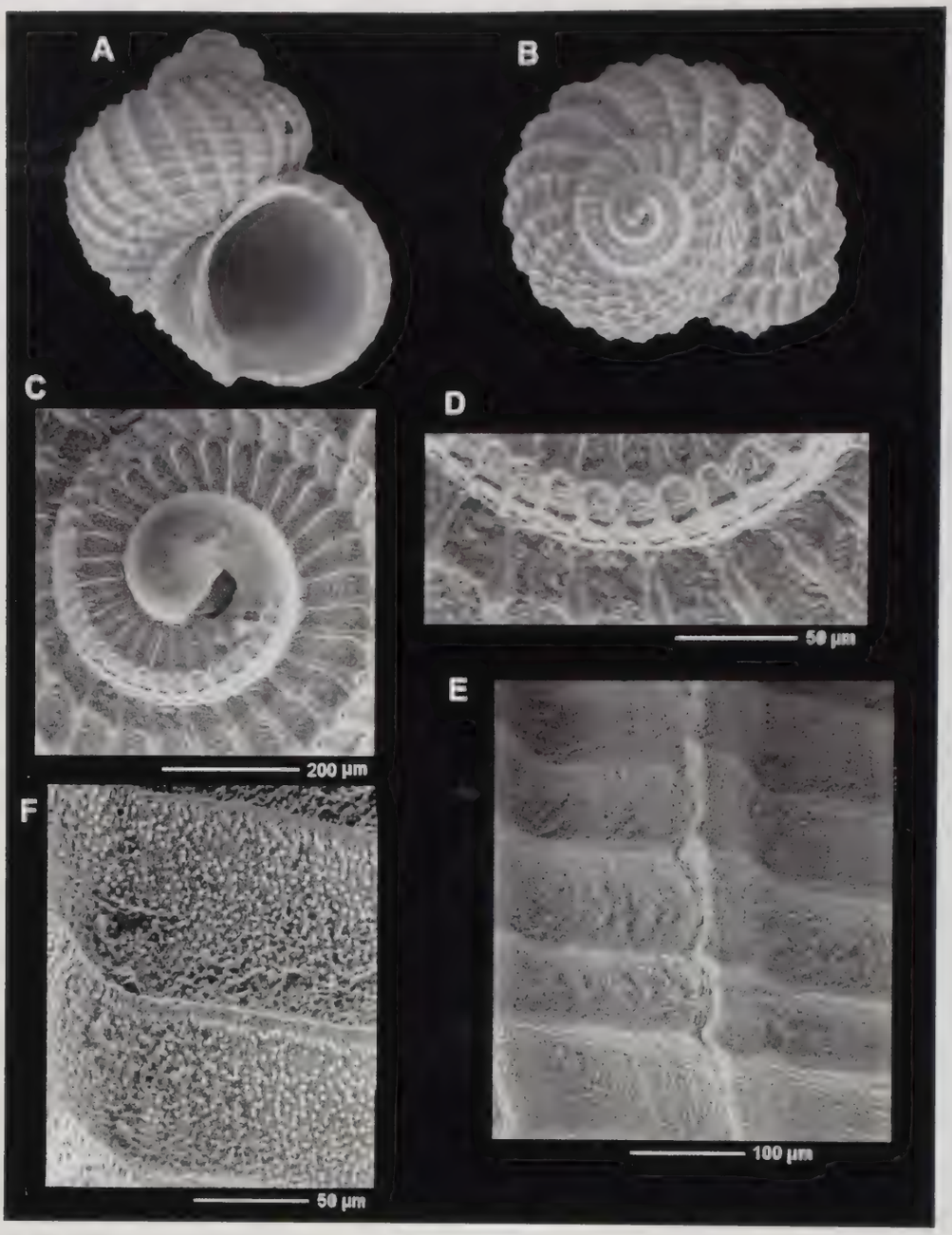

Figure 17A-F
Crosseola prosoclina n. sp. A-B. Holotype MNHN-IM-2000-34434, 3.97 mm, Vanuatu, 19°25'S-169°27'E, 160-182 m; C. Protoconch; D-F. Sculpture and microsculpture.

Etymology. The specific name alludes to the direction on the axial sculpture of the last whorl, which is more prosocline than in other species of the genus.

Crosseola osgrandis n. sp.
Fig. 18A-F

Type material. Holotype MNHN-IM-2000-34436 (Fig. 18A-C).

Type locality. Philippines, Bohol Sea, Pamilacan Island, 9°30'N-123°5'E, 196-216 m (PANGLAO 2005: CP2348).

Material examined. PANGLAO 2005, stn CP2348, 1 s, Philippines, Bohol Sea, Pamilacan Island, 9°60'N-123°53'E, 196-216 m (holotype).

Description. Shell of small size (<4 mm), not very robust, turbiniform, very low spire formed by 3 ½ whorls separated by a deep suture, not carinated and with a large last whorl.
The protoconch is formed by almost 1 whorl after the nucleus with a smooth surface and has a size of 240 µm in diameter.
The teleoconch has 3.5 whorls and its periphery is very convex. The ornamentation is formed by spiral

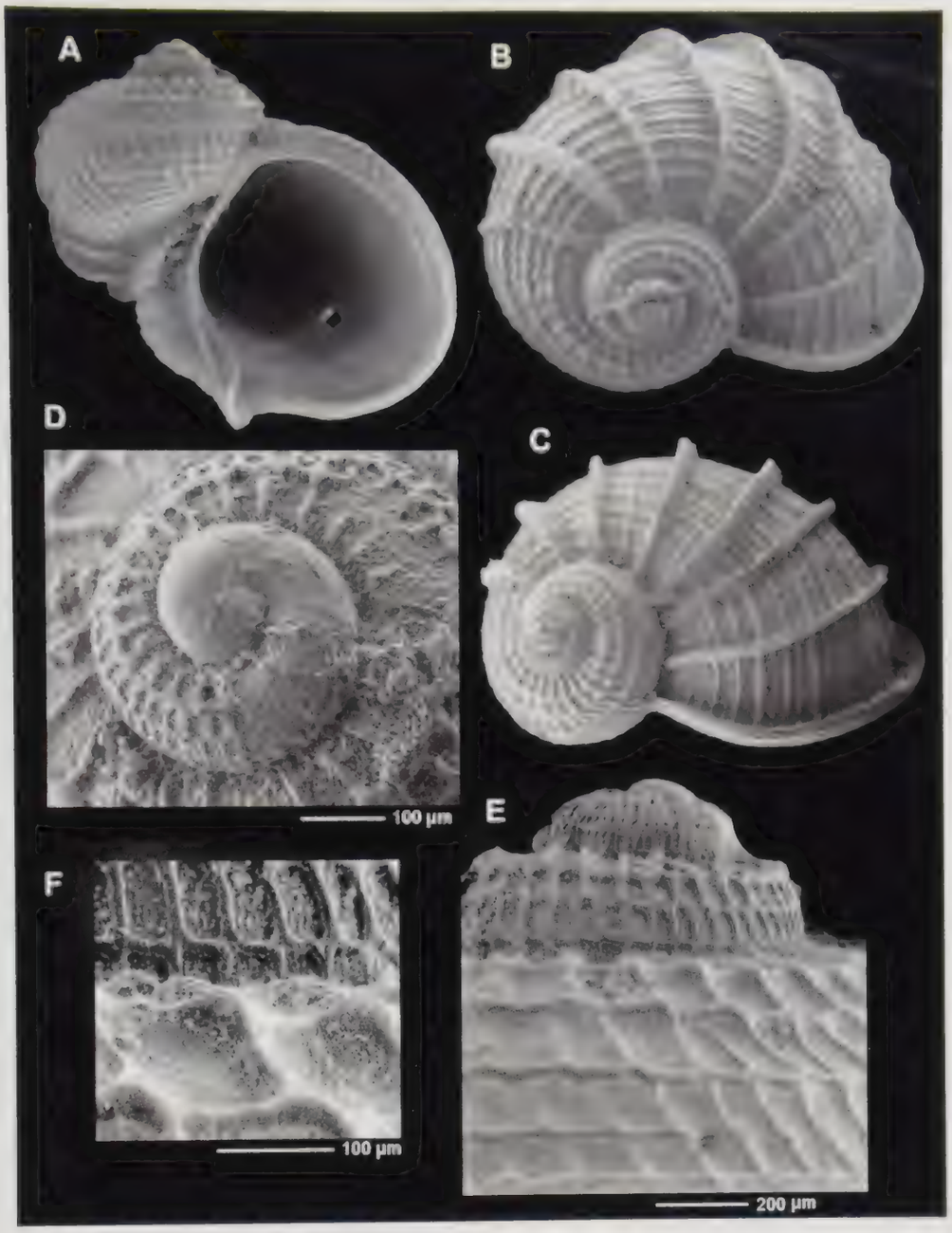

Figure 18A-F
Crosseola osgrandis n. sp. A-C. Holotype MNHN-IM-2000-34436, 3.53 mm in height, Philippines, Bohol Sea, Pamilacan Island, 9°30'N-123°5'E, 196-216 m; D. Protoconch; E-F. Lateral view of the protoconch and detail.

cords, axial ribs and microgranules. The spiral cords are narrow and cover the entire surface of the teleoconch. In the first whorl there are 3 cords, there are 4 in the second and on the last whorl (which has a greater size) there are about 22. The axial ribs are present in the two first whorls but disappear in the last half whorl, where they are substituted by labial enlargements. The axial ribs crossing the spiral cords form a regular reticle of rectangular spaces, mostly with an elevation at the intersections. On the last half whorl the rectangles at the crossing with the persistent labial enlargements are elongated. The interspaces are covered by microgranules.

A prominent cord borders and delimits the umbilical area; it has numerous fine prominent cordlets; the umbilicus as such is absent; the columella is fine and slightly curved with an extension below the aperture which looks like a siphonal fold.

Aperture rounded, large, without any prominence and only with an external enlargement on which the spiral cordlets cross.

Dimensions: The holotype is 3.53 mm in height and 3.80 mm in diameter (H/D = 0.93).

Habitat. Bathyal species dredged at 196-216 m in depth.

Distribution. Only known from the type locality.

Remarks. *Crosseola osgrandis* n. sp. is characterized by its enormous aperture and the presence of eight apertural enlargements which are preserved.
These characters make it different from any other species.

Etymology. The specific name alludes to the large size of the aperture, from the Latin *os, oris* "mouth" and *grandis, e* "large".

Crosseola sexlata n. sp.
Fig. 19A-D

Type material. Holotype MNHN-IM-2000-34437 (Fig. 19A-B).

Type locality. Philippines, Bohol Island/Sulu Seas sill, Dipolog Bay, 8°35'N-123°16'E, 172-175 m (PANGLAO 2005: DW2371).

Material examined. PANGLAO 2005, stn DW2371, 1 s, Philippines, Bohol/Sulu Seas sill, Dipolog Bay, 8°35'N-123°16'E, 172-175 m (holotype).

Description. Shell of small size (<2 mm), robust, turbiniform, with a medium short spire formed by slightly over 3 whorls separated by an evident suture, not carinated.
The protoconch is formed by ¾ of a whorl, with a smoth surface and has a size of about 250 µm in diameter. The teleoconch is formed by 2 ¾ whorls, and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow and cover the entire surface of the teleoconch, except a narrow subsutural area that goes from the beginning to the last whorl where the spiral sculpture appears again. The spiral cords are much narrower than their interspaces, and can number up to 14-15.
The axial ribs begin in the suture. They are scarce in the subsutural band on the two first whorls (about 19 on the first whorl). They are placed between the spiral cords, most of them form a nodule at the crossing point, forming an irregular reticle of rectangular spaces; in the lower part of the whorls, the axial ribs are stronger and are closer together. All the interspaces are covered by microgranules and occasionally by smaller cordlets.
A prominent cord borders and delimits the umbilical area; this cord is sculptured by many fine dense riblets, almost horizontal at the beginning and vertical later, lacking prolongations from the axial ribs of the last whorl. The umbilicus is reduced to a very narrow fisure that is practically occluded between the periumbilical cord and the columella. The columella is fine and slightly curved, with a reflected extension to the lower part of the aperture and finishes in a low neck or depressed line forming a siphonal fold, which extends below the aperture.
Aperture rounded and smooth. Peristome wide; the external margin is strongly thickened and in the last half whorl can be observed 6 more similar before the apertural one.
Dimensions: The holotype is 1.82 mm in height and 1.61 mm in diameter (H/D = 1.13).

Habitat. Bathyal species dredged at 172-175 m deep.

Distribution. Only known from the type locality.

Remarks. The most important characters of *Crosseola sexlata* n. sp. are the last axial ribs, which are wider than the previous ones; the axial and spiral sculpture, which are crossed; and the prominence in the base which surpasses the lower border of the aperture.
Crosseola solomonensis Rubio & Rolán, 2017, has a similar form and sculpture, but it has otherwise several differences: it has a smaller protoconch diameter (220 µm vs 250 in the present species); The axial sculpture of the teleoconch is not regular, having 20 ribs on the first whorl and 24 on the second (vs 20 on the first one and 30 on the second in *C. sexlata* n. sp.); in *C. solomonensis* the axial ribs on the last whorl are 15 but rather similar, having only the last ones larger interspaces between; in contrast the last 6 axial ribs in *C. sexlata* n. sp. are evidently wider than the previous; the lowest part on the last whorl in *C. solomonensis* is the lower apertural border, while in *C. sexlata* it is the prolongation of the periumbilical cord; Finally, in the last whorl, the subsutural spiral cords, in *C. solomonensis*, are moved away from the suture while others are appearing; in contrast, in *C. sexlata* n. sp. the spiral cordlets also are moving away, but no new ones are formed keeping a subsutural band without any spiral cordlets.

Etymology. The specific name is formed by the Latin words *sex* "six" and *latus, a, um* "wide", alluding to the facts that the last axial ribs, at the last whorl, are wider that the previous ones.

Crosseola benedotata n. sp.
Fig. 20A-F

Type material. Holotype MNHN-IM-2000-34438 (Fig. 20A-B).

Type locality. New Caledonia, East Coast, 20°35'S-165°07'E, 380-400 m (BATHUS 1: DW683).

Material examined. BATHUS 1, stn DW683, 1 s, New Caledonia, East Coast, 20°35'S-165°07'E, 380-400 m (holotype).

Description. Shell of small size (<2 mm), robust, turbiniform, with a medium sized spire formed by

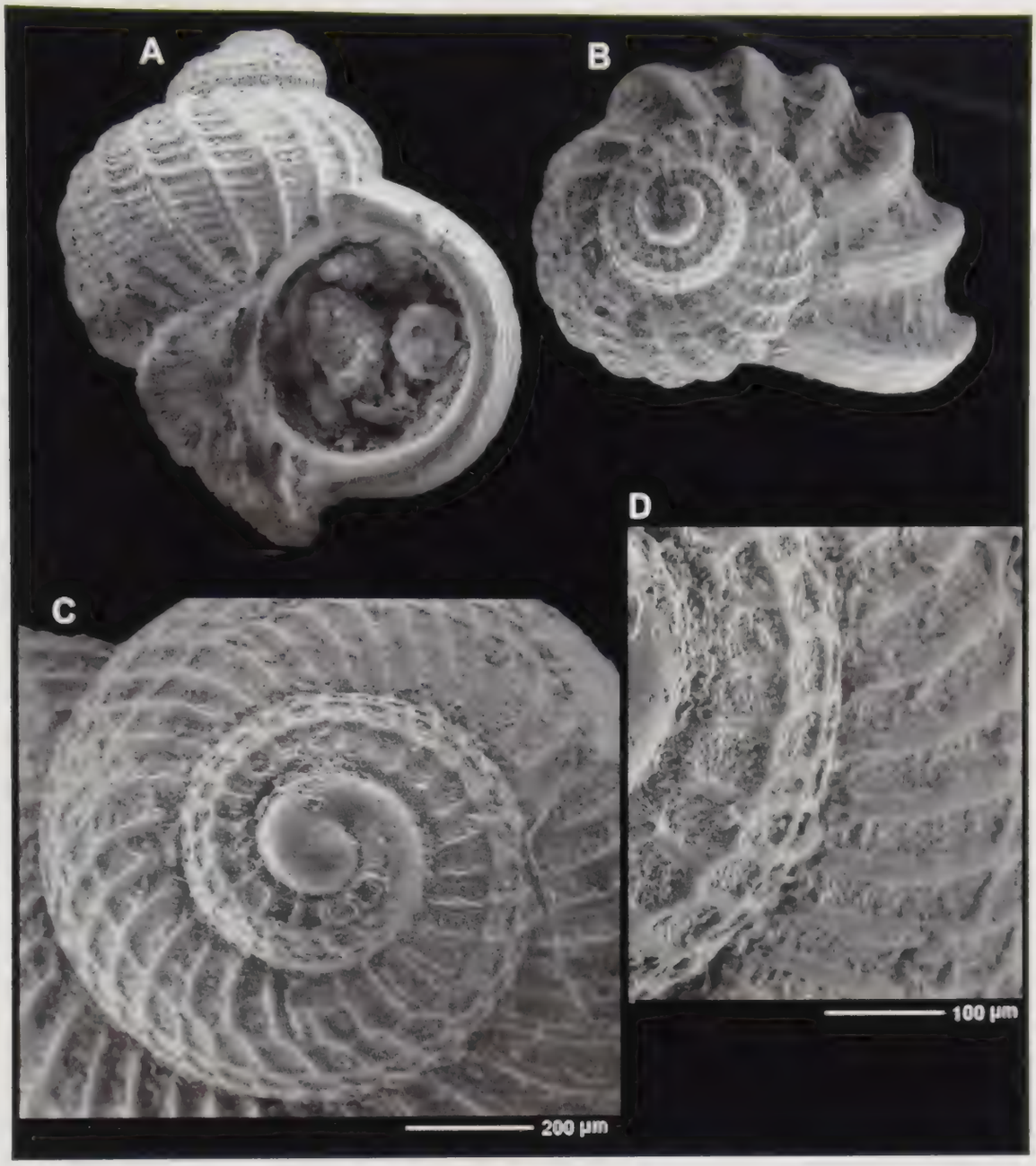

Figure 19A-D
Crosseola sexlata n. sp. A-B. Holotype MNHN-IM-2000-34437, 1.82 mm, Philippines, Bohol Island, Sulu Seas sill, Dipolog Bay, 8°35'N-123°16'E, 172-175 m; C. Apex and protoconch; D. detail.

about 3 whorls separated by an evident suture, not carinated.

The protoconch is formed by little more than ½ of a whorl, with a smooth surface and has a size of about 200 µm in diameter. The teleoconch is formed by 2 ½ whorls, and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow, and cover the entire surface of the teleoconch, except a broad subsutural area that goes from the beginning to the last whorls where the spiral sculpture can be seen again. The spiral cords are much narrower than their interspaces.

The axial ribs begin at the suture; they are fewer at the subsutural band than in at the lower part of the two first whorls. They are crossed by the spiral cords, forming an irregular reticle of rectangular/quadrangular spaces; in the lower part of the whorls, the axial ribs are more numerous. All the interspaces are covered by microgranules.

A prominent cord borders and delimits the umbilical area; this cord is scultured by many fine dense axial riblets which protude from those at the last whorl. The umbilicus is reduced to a very narrow fisure that is axialy extended between the periumbilical cord and the columella. The columella is fine and slightly curved with two reflected parts, one towards the periumbilical cord, and the other to the inner part of the aperture, as a basal projection like a siphonal fold.

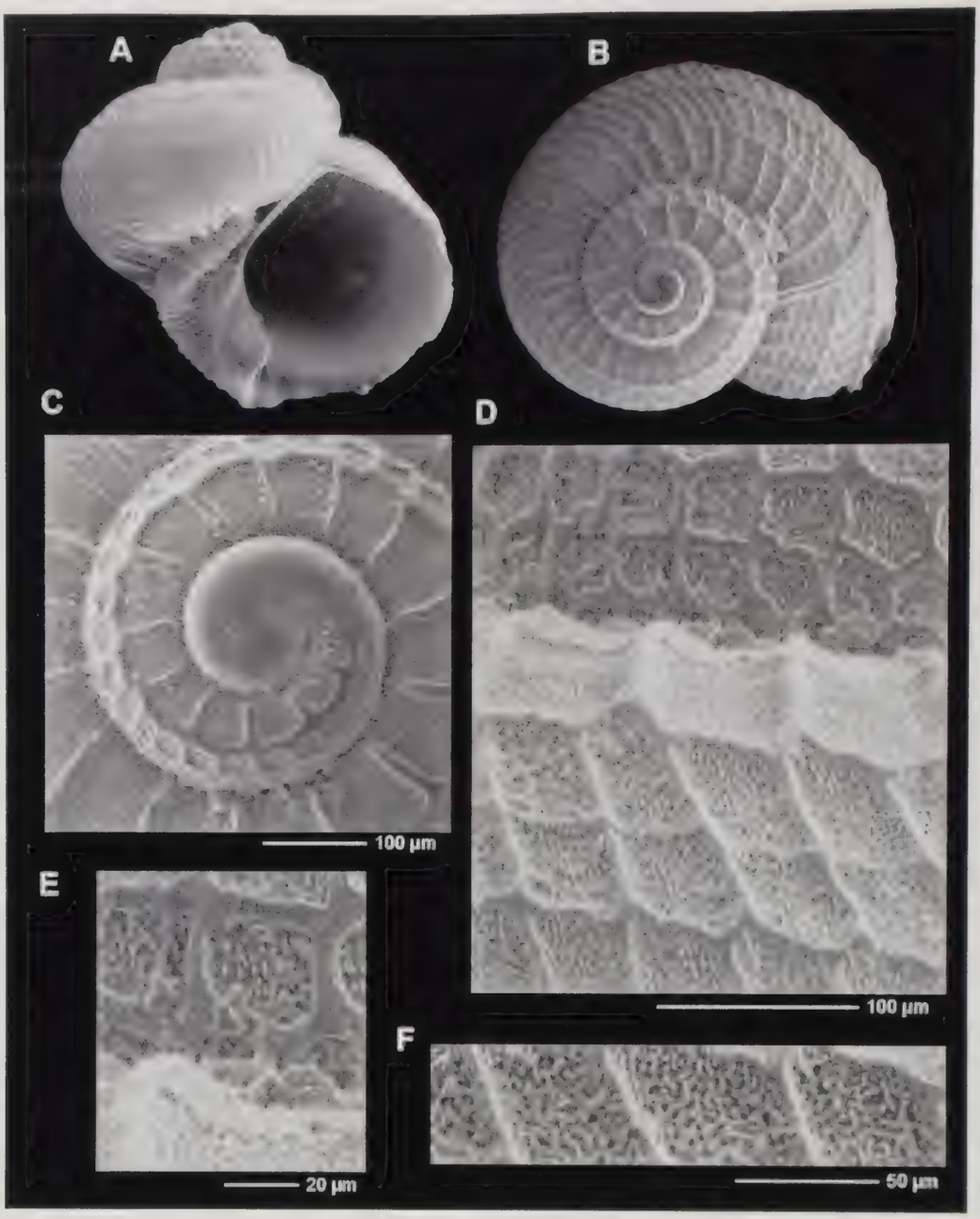

Figure 20A-F
Crosseola benedotata n. sp. A-B. Holotype MNHN-IM-2000-34438, 1.46 mm, New Caledonia, East Coast, 20°35'S-165°07'E, 380-400 m; C. Protoconch; D-F. Sculpture and detail.

Aperture rounded, smooth. Outer lip very fine and sharp; the external margin is not thickened or variciform.
Dimensions: The holotype is 1.46 mm in height and 1.46 in diameter (H/D = 1.0).

Habitat. Bathyal species dredged at 380-400 m depth.

Distribution. Only known from the type locality.

Remarks. *Crosseola benedotata* n. sp. is characterized by a sculpture scarcely prominent except the periumbilical cord, which forms smaller reticulation.

Some species have a little similarity: see below for the comparison with *C. axialis* n. sp., *C. minireticula* n. sp. and *C. occlusa* n. sp.

Etymology. The specific name is formed by two Latin words: *bene* "well" and *dotatus, a, um* "endowed" which alludes to the fact that the species possesses the typical characters of the genus,

Crosseola axialis n. sp.
Figs 21A-F, 22A-G

Type material. Holotype MNHN-IM-2000-34439 (Fig. 21A-B) and 2 paratypes MNHN-IM-2000-34440 (Fig. 22A-D).

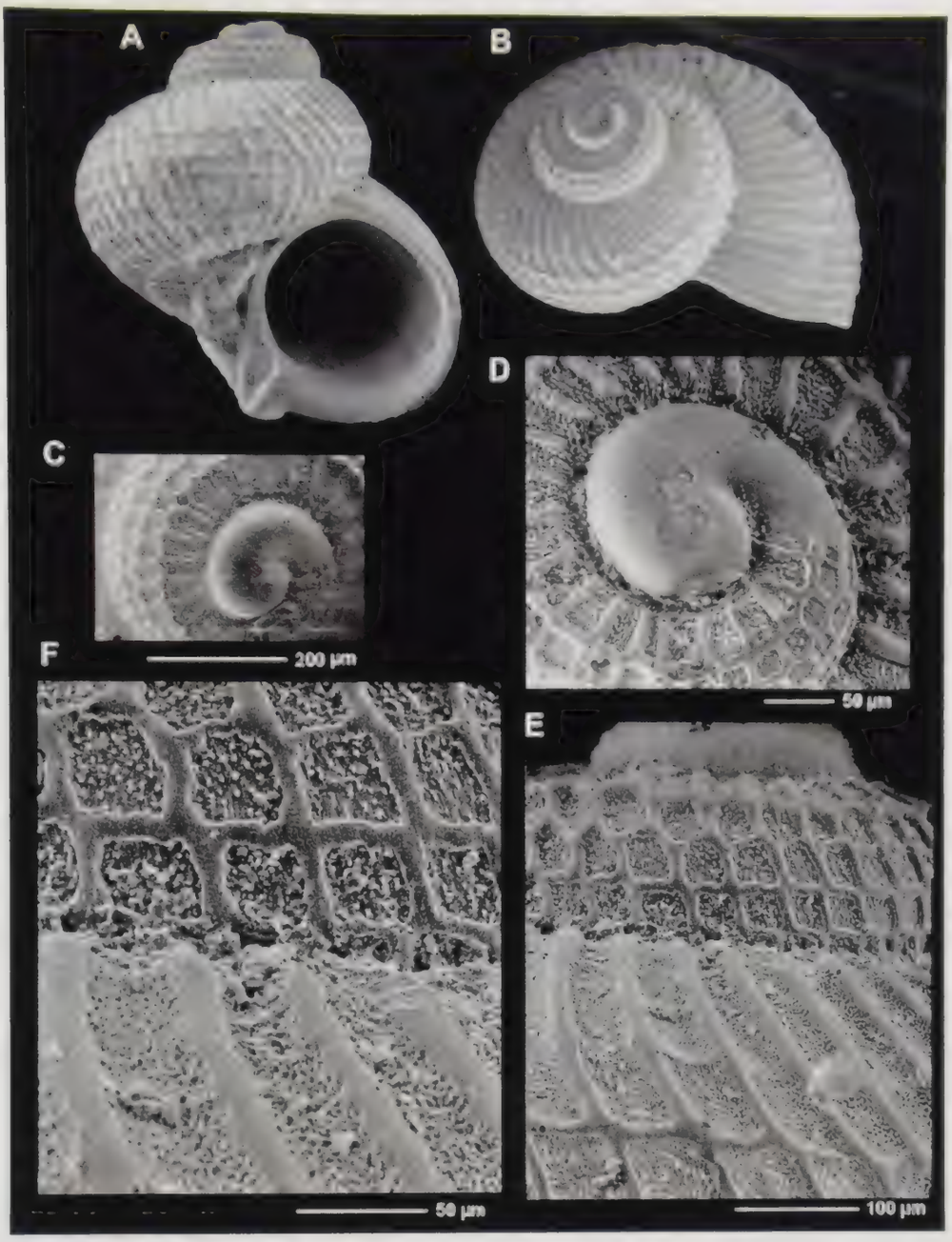

Figure 21A-G
Crosseola axialis n. sp. A-B. Holotype MNHN-IM-2000-34439, 1.26 mm, Fiji, S Viti Levu, 18°11'S-178°23'E, 393-433 m; C-D. Protoconch; E-F. Sculpture and detail.

Type locality. Fiji, S Viti Levu, 18°11'S-178°23'E, 393-433 m (MUSORSTOM 10: stn CP1369).

Material examined. MUSORSTOM 10, stn CP1369, 1 s, Fiji, S Viti Levu, 18°11'S-178°23'E, 393-433 m (holotype); 2 s, S Viti Levu, stn DW1381, 18°18'S-177°54'E, 275-430 m (paratypes).

Description. Shell of small size (<2 mm), robust, turbiniform, with a spire of medium size formed by about 3 whorls separated by an evident suture, not carinated.
The protoconch is formed by little more than ½ of a whorl with a smooth surface and is about 210 µm in diameter. The teleoconch is formed by almost 2 ½ whorls and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow, about 8 on the last whorl, and cover the entire surface of the teleoconch, except a broad subsutural area that goes from the beginning to the last whorl, where it is more evident; the spiral cords are narrower than their interspaces.
The axial ribs begin in the suture, and except in the subsutural band, are crossed by the spiral cords, forming an irregular reticle of rectangular/quadrangular spaces; later, the axial ribs continue but are only on the lower part. The interspaces are covered by microgranules.

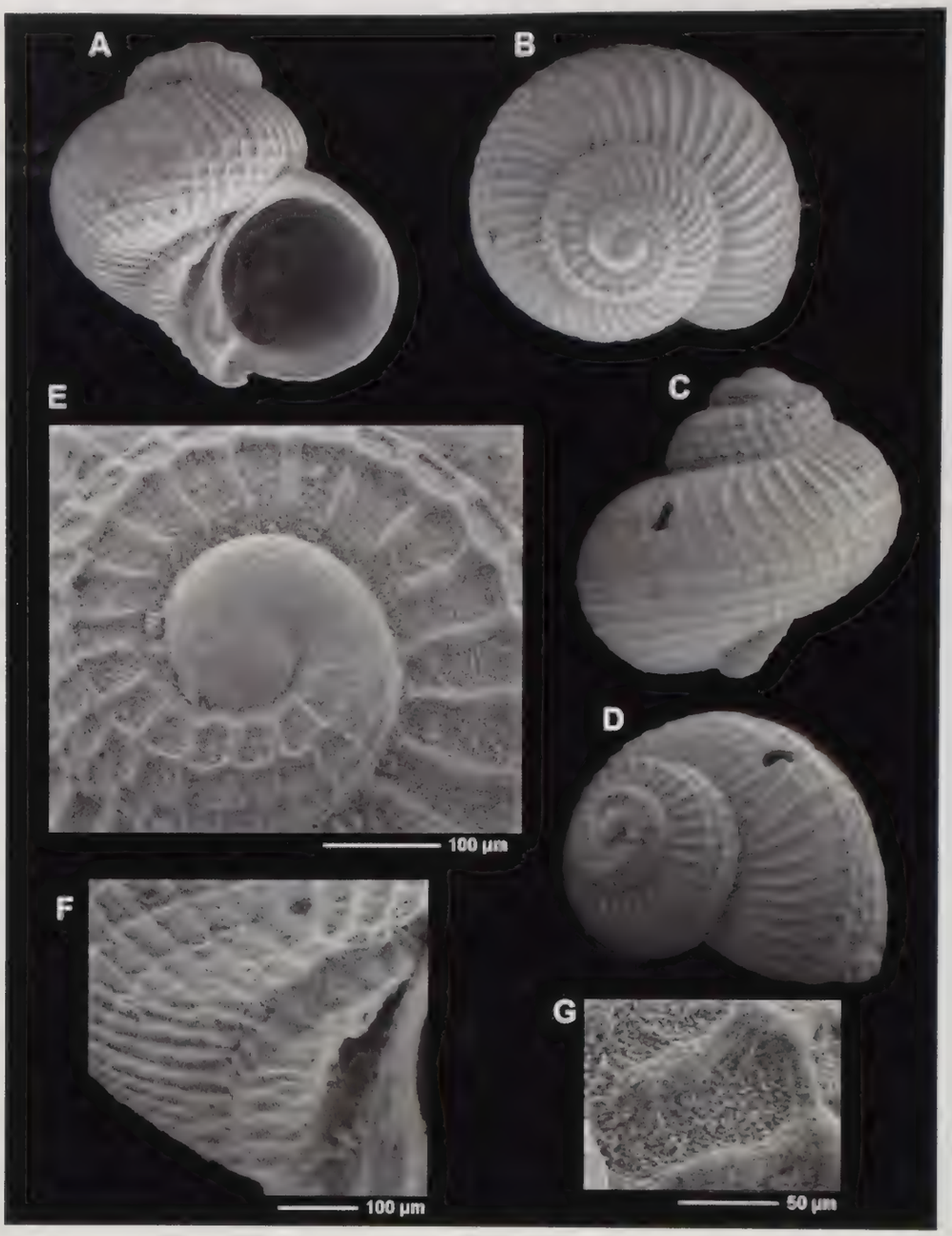

Figure 22A-G
Crosseola axialis n. sp. A-B. Paratype MNHN-IM-2000-34440, 1.21 mm, Fiji, S Viti Levu, 18°18'S-177°54'E, 275-430 m; C-D. Paratype MNHN-IM-2000-34440, 1.14 mm in height, same locality; E. Protoconch of one paratype; F-G. Details of the umbilical area and microsculpture.

A prominent cord borders and delimits the umbilical area; this cord is scultured by many fine axial riblets. The umbilicus is reduced to a narrow fisure that is axialy extended between the periumbilical cord and the columella.

Aperture rounded, prosocline; columella narrow, fine and a little reflected towards the base, where is prominent and has an axial small depression below which reminds to a siphon. Outer lip smooth; the external margin is not thickened or variciform.

Dimensions: The holotype measures 1.26 mm in height and 1.21 mm in diameter (H/D = 1.11).

Habitat. Bathyal species dredged between 168-393 m.

Distribution. Only known from the type locality.

Remarks. Similar species are the following: *Crosseola benedotata* n. sp. has a fewer axial riblets at the beginning of the spire (12 on the first whorl compared to the 22 in *C. axialis* n. sp.); it has otherwise more spiral cordlets (15 on the last whorl compared to the 8 in *C. axialis* n. sp.). The sculpture of this species is very irregular, in contrast to the regularity of *C. axialis*.

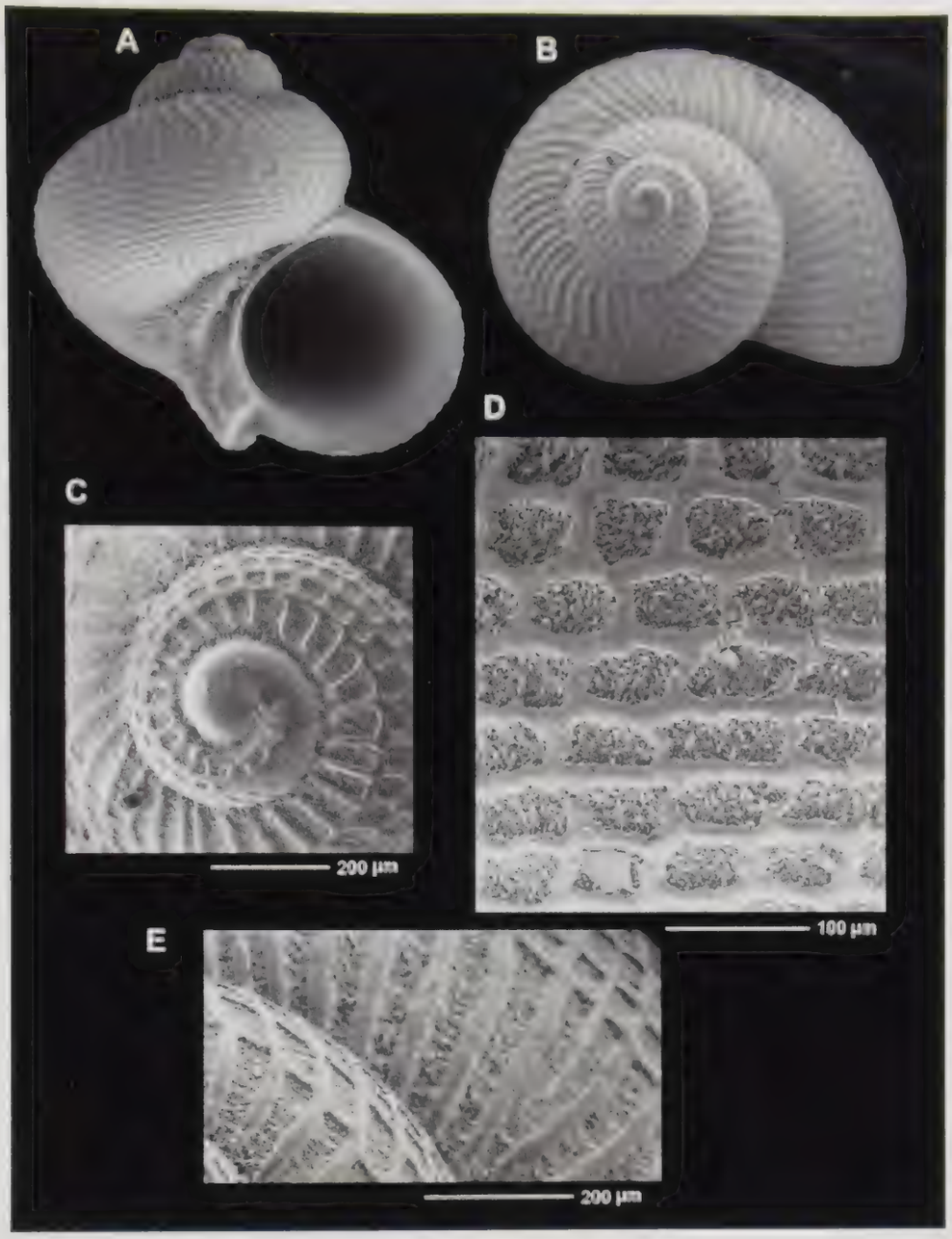

Figure 23A-E
Crosseola minireticula n. sp. A-B. Holotype MNHN-IM-2000-34441, 1.77 mm in height. Philippines, Bohol Island, Sulu Seas sill, Dipolog Bay, 08°41'N-123°18'E, 150-163 m; C. Protoconch; D-E. Detail of the sculpture.

Crosseola similiter (see Rubio & Rolán, 2017a) from Solomón Is. has a similar aspect but with more spiral cordlets (11 vs 6 on the last whorl in *C. axialis*). Also the subsutural band, without spiral cords, is smaller in this species.

Etymology. The specific name alludes to the axial sculpture which is extended in all the surface of the shell, while it is reduced in the subsutural area.

Crosseola minireticula n. sp.
Fig. 23A-E

Type material. Holotype MNHN-IM-2000-34441 (Fig. 23A-B).

Type locality. Philippines, Bohol Island, Sulu Seas sill, Dipolog Bay, 8°41'N-123°18'E, 150-163 m (PANGLAO 2005: CP2380).

Material examined. PANGLAO 2005, stn CP2380, 1 s, Philippines, Bohol Island, Sulu Seas sill, Dipolog Bay, 8°41'N-123°18'E, 150-163 m.

Description. Shell of small size (<2 mm), robust, turbiniform, with a medium sized spire formed by little more than 3 whorls separated by an evident suture, not carinated.
The protoconch is formed by about 0.5 whorls, a smooth surface and has an approximate size of 240 µm in diameter.

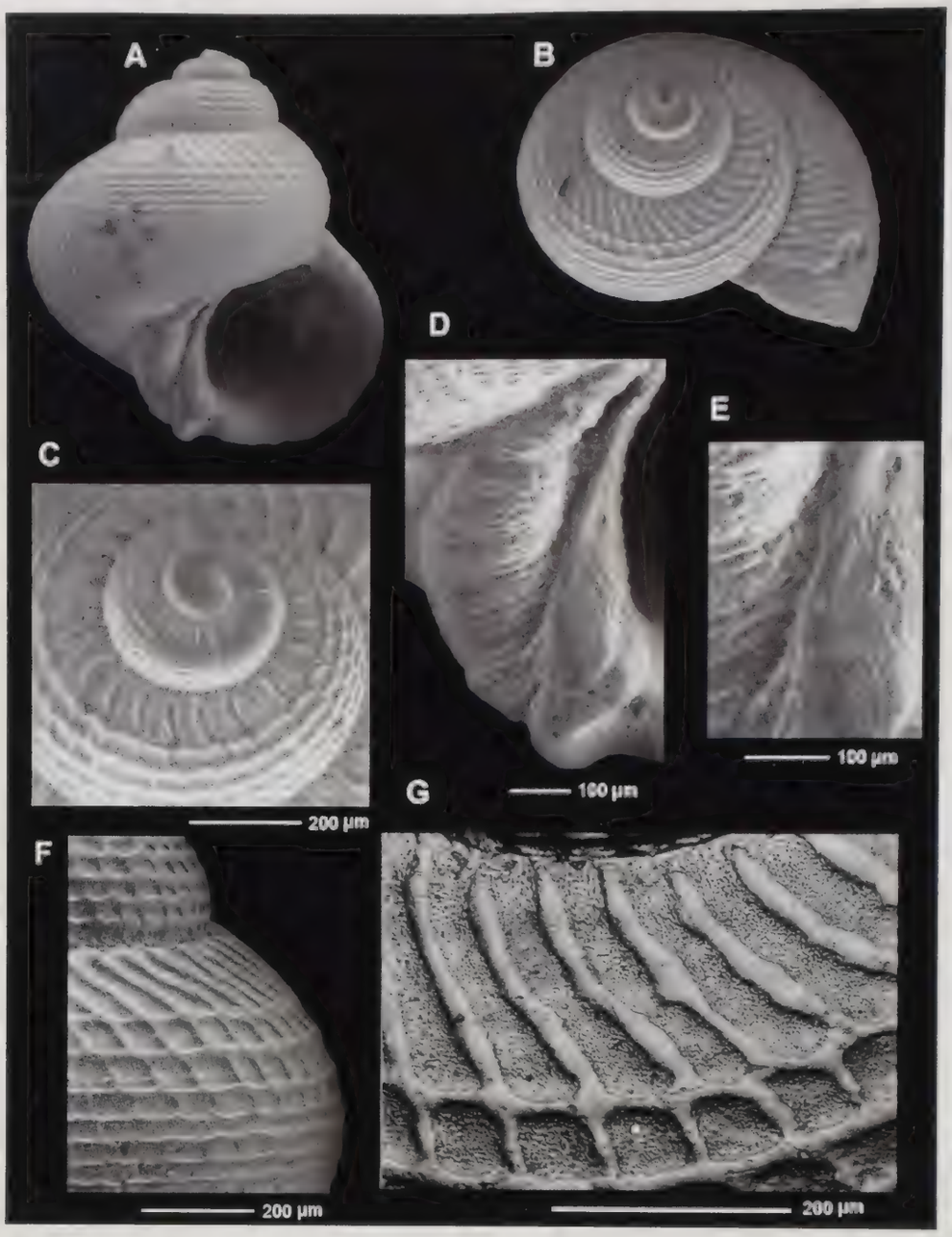

Figure 24A-F
Crosseola occlusa n. sp. A-B. Holotype MNHN-IM-2000-34442, 1.83 mm, Solomon Is., 08°40'S-160°04'E, 396-411 m; C. Protoconch; D-E. Umbilical area and detail; F-G. Sculpture and detail.

The teleoconch is formed by little more than 2 ½ whorls and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow, and cover the entire surface of the teleoconch, except a broad subsutural area that goes from the beginning and finishes on the last whorl, where there are 25 more conspicuous spiral cords; the spiral cords are narrower than their interspaces.

The axial ribs begin in the suture, and in the first two whorls they cross the spiral cords forming an irregular reticle of numerous rectangular/quadrangular or oval spaces; later, the axial ribs continue but the spiral sculpture is shallower. The interspaces are covered by microgranules.

A moderately strong cord borders and delimits the umbilical area; this cord is sculptured by many fine axial riblets. The umbilicus is reduced to a narrow fissure that is extended between the periumbilical cord and the columella.

Aperture rounded, prosocline, columella narrow, fine a little reflected towards the base, where it is prominent and has an axial small depression below which looks like a siphon. Outer lip smooth; the external margin is not thickened or variciform.

Dimensions: The holotype measures 1.77 mm in height and the same in diameter (H/D = 1.0).

Habitat. Bathyal species dredged at 150-163 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola minireticula* n. sp. is characterized by having its surface totaly covered by a reticle, with the exception of the subsutural area, where there is no spiral sculpture, and the area around the periumbilical cord.
Crosseola benedotata n. sp. has a somewhat similar shell, but a closer look reveal several different characters: it has a smaller protoconch (200 µm compared to the 240 in *C. minireticula*); the axial sculpture is not so abundant on the first two whorls (12 riblets compared to the about 25 in *C. minireticula*); the number of the spiral cordlets is clearly smaller; finally, the internal expansion of the columella is a little larger and the aperture is a little more irregular..
Crosseola axialis n. sp. from Fiji is rather similar but this species is a little smaller, the reticular sculpture is coarser (about 7 spiral cordlets from the last whorl down to the umbilicus compared to the 14 in *C. minireticula*); the periumbilical cord is wider and the prolongation of the axial ribs which cover it are less pronounced. The protoconch is a little smaller (210 compared to the 240 µm in *C. minireticulata*).
Crosseola similiter (Rubio & Rolán, 2017) from Solomon Is. has a similar aspect but with fewer spiral cordlets (11 compared to the 6 on the last whorl in *C. minireticulata*). Also the subsutural band, without spiral cords, is smaller in this species.

Etymology. The specifc name alludes to the fine, net-like sculpture of the shell, from the Latin *minimus, a, um* "very small" and *reticulatus, a, um* "netted".

Crosseola occlusa n. sp.
Fig. 24A-G

Type material. Holotype MNHN-IM-2000-34442 (Fig. 24A-B).

Type locality. Solomon Is., 8°40'S-160°04'E, 396-411 m (SALOMON 1: stn DW1762).

Material examined. SALOMON 1, stn DW1762, 1 s, Solomon Is, 8°40'S-160°04'E, 396-411 m.

Description. Shell of small size (<2 mm), robust, turbiniform, with a medium sized spire formed by about 3 ¾ whorls separated by an evident suture, not carinated.
The protoconch is formed by about 0.5 whorls, a smooth surface and has an approximate size of 200 µm in diameter.
The teleoconch has 3 ¼ whorls and its periphery is very convex. The ornamentation is formed by spiral cords, axial ribs and microgranules. The spiral cords are narrow, and cover the entire surface of the teleoconch, except a broad subsutural area that starts at the beginning, being more evident on the last whorl; these spiral cords are narrower than their interspaces.
The axial ribs begin in the suture, and cross the spiral cords at the first two whorls forming a regular reticle of rectangular/quadrangular spaces; later, the spaces lengthen becoming progressively into narrow and shallow grooves. The interspaces are covered by microgranules.
A prominent cord borders and delimits the umbilical area; the umbilicus is reduced to a narrow fisure that extends between the periumbilical cord and the columella. The surface of this cord is completely covered by irregular axial riblets
Aperture rounded, prosocline; columella narrow, a little reflected towards the base, where it is prominent and has a small, basal, notch-like indentation. Outer lip smooth; the external margin is not thickened or variciform.
Dimensions: holotype is 1.82 mm in height and 1.62 mm in diameter (H/D = 1.12).

Habitat. Bathyal species dredged at 396-411 m deep.

Distribution. Only known from the type locality.

Remarks. *Crosseola occlusa* n. sp. is characterized by an abundant spiral sculpture and a broad periumbilical cord.
Crosseola benedotata n. sp. and *C. axialis* n. sp. have a coarser sculpture, wider rectangles and a narrower periumbilical cord.
Crosseola minireticula n. sp. has almost the same number of spiral cordlets on the last whorl, but while *C. occlusa* has 6 on the previous whorl, *C. minireticula* has 4; also the periumbilical cord is narrower than that of *C. occlusa*.
Crosseola similiter (Rubio & Rolán, 2017) from Solomón Is. has a similar aspect but with many more spiral cordlets and with a periumbilical cord much larger.

Etymology. The specific name alludes to the almost closed umbilicus due the size of the periumbilical cord.

Addendum

When we had this paper ready for publication, we were noticed that one species which we had in the list of the new species was recently published by Poppe, Tagaro & Goto (2018) in a different genus.
In order to show this information, we present this species in this addendum:

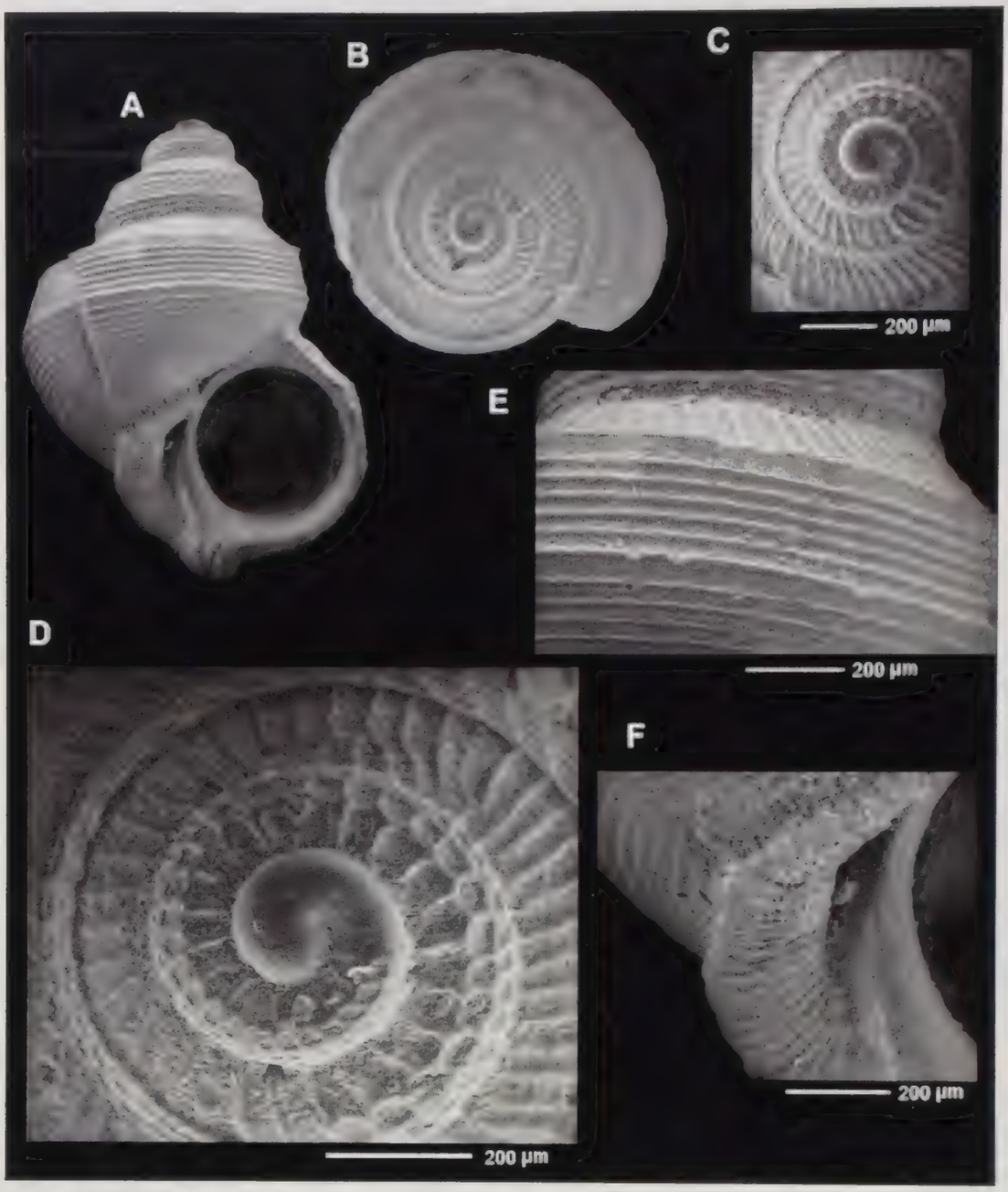

Figure 25A-F
Crosseola escondida (Poppe, Tagaro & Goto, 2018). A-B: shell, 2.22 mm in height, Philippines, Bohol/Sulu Seas sill, 9°00.7'N-123°25.5'E, 427 m (MNHN); C-D: protoconch and first teleoconch whorl; E-F: sculpture

Crosseola escondida
(Poppe, Tagaro & Goto, 2018) n. comb
Figs 25A-F, 26

Lophocochlias escondidus Poppe, Tagaro & Goto, 2018: 99, pl. 6, figs 1-2 (Type locality: Mactan Island, Punta Engaño, Malingin, Philippines).

Type material. Holotype and paratype examined by photographs. Paratype MNHN-IM-2014-6942, ex coll. G. Poppe, examined by photograph (Fig. 26).

Material examined. PANGLAO 2005, stn DW2364, 1 s, Philippines, Bohol/Sulu Seas sill, 9°00.7'N-123°25.5'E, 427 m.

Description. Original description in Poppe, Tagaro & Gotto (2018).

Habitat. Bathyal species dredged between 200-427 m deep.

Distribution. Only known from Mactan and Bohol Island, Philippines.

Remarks. *Lophocochlias escondidus* was described by Poppe, Tagaro & Goto (2018) and placed in the genus *Lophocochlias* Pilsbry, 1921 for its apparent similarity with *Lophocochlias procerus* Rubio & Rolán, 2015. However, *L. escondidus*, unlike its congeners, has a paucispiral protoconch, more typical of a Vetigastropod, with only 0.8 whorls, of rough surface and two spiral cords.

In addition to the characters of the protoconch, *L. escondidus* has the typical characters of the genus *Crosseola*, described by Hickman (2013): "Shell turbinate with characteristic sculpture (regular reticle of rectangular / quadrangular spaces) at beginning of the teleoconch; unique umbilical keel; narrow pseudo-umbilicus and columella with an anterior canal at the base".

For all these reasons, we consider that *Lophocochlias escondidus* has to leave its systematic position in *Lophocochlias* (Tornidae) and be assigned *Crosseola* (Conradiidae).

Figure 26
Crosseola escondida (Poppe, Tagaro & Goto, 2018). Paratype MNHN-IM-2014-6942, 1.50 mm in height, Philippines, Mactan Island, Punta Engaño, Malingin, 400 m.

Genus ***Crossolida*** n. gen.

Remarks. When we studied the species we had initially assigned to the genus *Crosseola*, we were surprised by the discovery of three of them which had very different characters from those of the species studied so far, although undoubtedly belonging to different species. So the idea that it could be an undescribed genus seemed logical to us. This idea was reinforced when we examined the protoconchs, which also had similar and different characters to those of *Crosseola*. We are therefore describing these species in a new genus.

Type species: *Crossolida robusta* n. sp.

Diagnosis: Shell small (the known species are smaller than 2.5 mm), very solid, with sculpture being mainly spiral. Spire elevated, obtuse at the apex; periphery and base convex. Protoconch of between 320-380 µm and formed by little more than one whorl, sculptured by tubercles (sometimes numerous and small, in others fewer and larger) which have tendency to be concentrated in a spiral cord on its convexity. Teleoconch formed by 2-3 whorls with a rapid increase in size and spiral sculpture. Umbilicus may be almost closed or opened but always surrounded by a very wide and prominent periumbilical cord, and sometimes by a second one smaller and closer to the umbilicus. Aperture rounded, columella curved; at the end of the spire there is a characteristic strong reinforcement of the outer lip.

Remarks. The species in this new genus may be separated from those of the genus *Crosseola* by its wide protoconch, always with tubercles, which are concentrate in the median line forming a cord that is never smooth (in opposition, the protoconch of *Crosseola* is always smaller than one whorl and its surface is smooth); the shell is stronger, with predominance of spiral sculpture, a separate and prominent periumbilical wide cord, and usually a second one that is smaller and closer to the umbilicus; outer lip strongly thickened.

Revising the literature we have found that a species recently described had these characters we have mentioned in the new genus. This species is *Crosseola marquesensis*, described and figured in Rubio, Rolán & Letourneux (2017: 22, fig. 3) from which the following is referred in the text: "Protoconch of 1.25 whorls with a maximum diameter of 380 µm; it has a strong spiral cord that begins in the nucleus and continues as a keel until near the end of the protoconch; its surface is covered by irregular microgranules". For this reason and the other characters of the shell, this species is clearly into the new genus, and so its correct name would be *Crossolida marquesensis* (Rubio, Rolán & Letourneux, 1917).

Etymology. The genus name is derived from the fusion of the beginning of the name *Crossea* and the Latin word *solidus, a, um* which means "solid, robust" making allusion to their solid aspect. *Crossolida* is a feminine name

Crossolida robusta n. sp.
Fig. 27A-F

Type material. Holotype MNHN-IM-2000-34443 (Fig. 27A-B).

Type locality. French Polynesia, Fatu-Hiva Is., 10°29'S-138°40.2'W, 49 m (SMCB: stn D86).

Material examined. SMCB, stn D86, 1 s, French Polynesia, Fatu-Hiva Is., 10°29'S-138°40.2'W, 49 m.

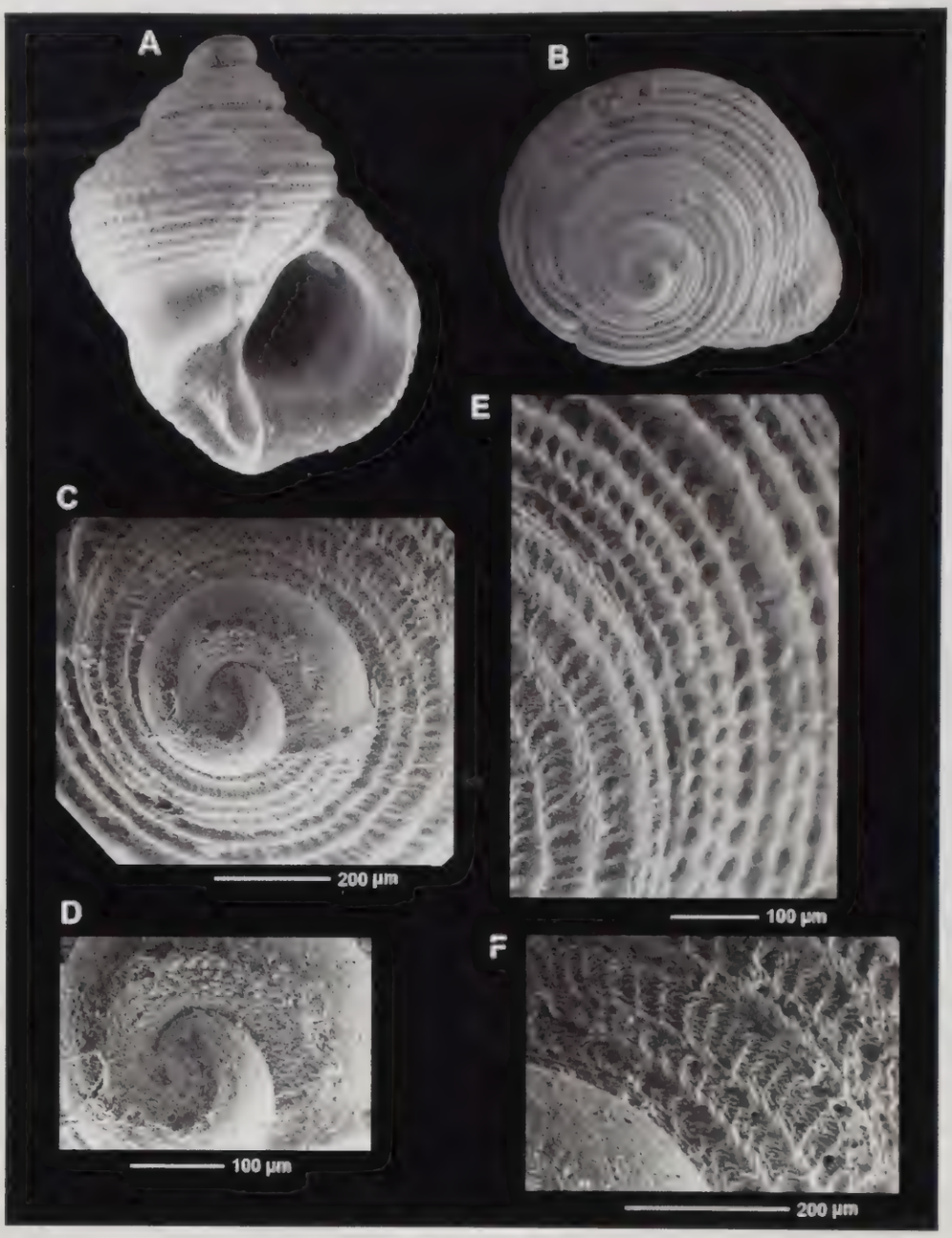

Figure 27A-F
Crossolida robusta n. sp. A-B. Holotype MNHN-IM-2000-34443, 1.78 mm in height, French Polynesia, Ile de Fatu-Hiva, 10°29'S-138°40.2'W, 49 m; C-D. Protoconch and detail; E-F. Sculpture and detail.

Description. Shell of small size (<2.00 mm), turbiniform, with a high spire formed by 3 whorls separated by a shallow suture, with an axial varicose outer lip and a narrow umbilicus. Protoconch formed by 1.2 whorls with a maximum diameter of 380 µm; it has a strong spiral cord that begins in the nucleus and continues as a keel until near the end of the protoconch; its surface is covered by many irregular and very small microgranules. The teleoconch is formed by little more than 2 whorls and its periphery is rounded. The ornamentation is formed by spiral cords, very fine in the first whorl and wider in the second one; on the first whorl, the five spiral cords have wide interspaces where numerous axial prosocline riblets are present. In the second whorl, the spiral cords are about 10, those at the middle of the whorl being wider; the interspaces are narrower than at the cords and there are numerous axial riblets and growth lines in them. Below the spiral cords there is an almost smooth depressed area and, immediately after, a wide strong spiral cord appears and finishes at the extreme of the base. This cord is placed around the umbilicus and has 6-8 fine spiral cords.

Aperture oval almost rounded, columella arched, reflected towards the umbilicus, outer lip very wide with a thickened external margin. Umbilicus narrow and deep, formed between the periumbilical cord and

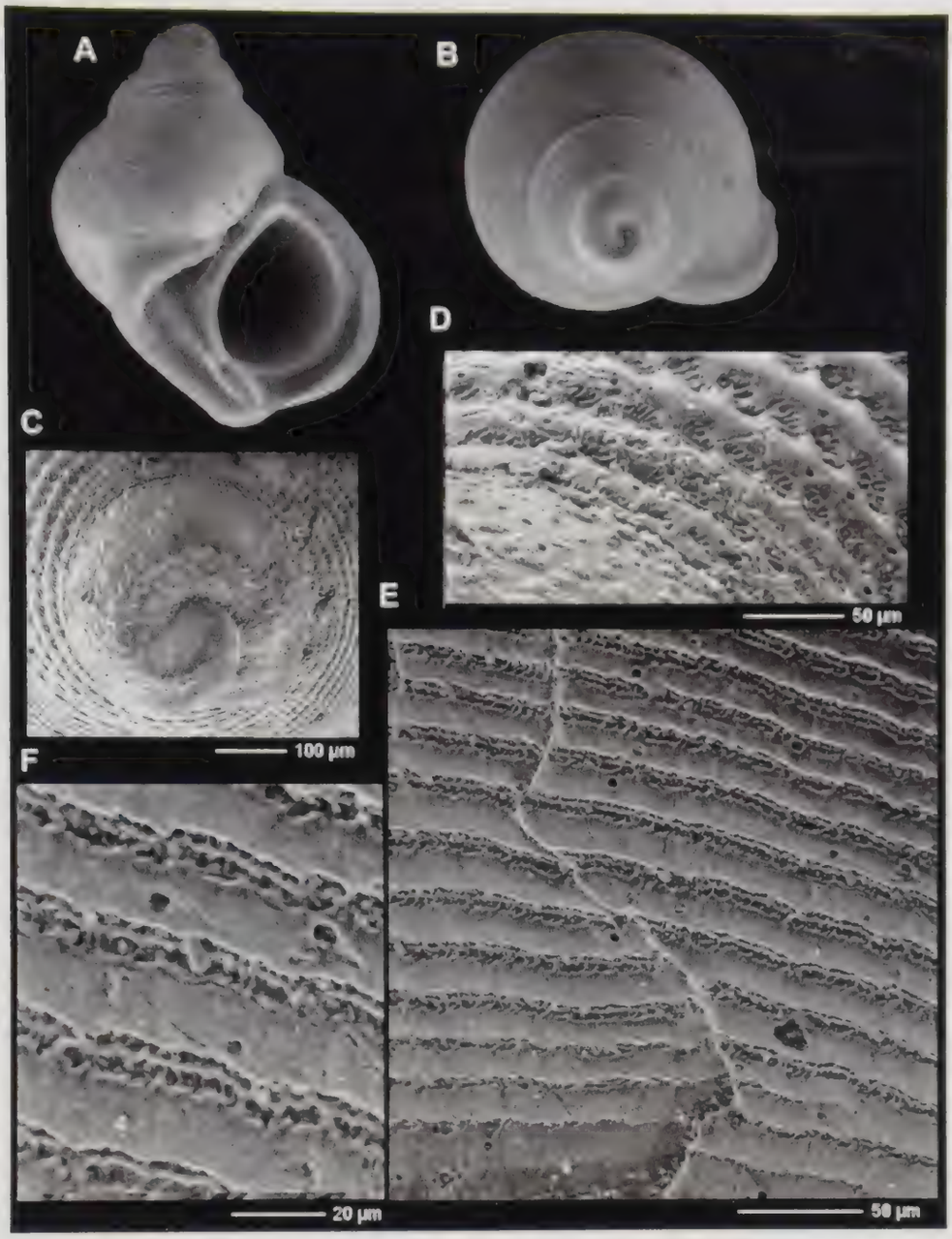

Figure 28A-F
Crossolida satispiralis n. sp. A-B. Holotype MNHN-IM-2000-34444, 1.6 mm, Vanuatu, 14°52'S-167°18'E, 1550-1620 m; C. Protoconch; D-F. Sculpture and details.

the columellar lip. Outer lip fine, modified at the base and elongated by the end of the periumbilical cord.
Dimensions: The holotype measures 1.78 mm in height and 1.3 in diameter (H/D = 1.37).

Habitat. Circalittoral species collected at 49 m deep.

Distribution. Only known from the type locality.

Remarks. *Crossolida robusta* n. sp. is characterized by those characters which are present on the new genus, of which it is the type species: its differentiation must be made with the congeneric species.

Crossolida satispiralis n. sp. has a spiral sculpture smaller and delicate, with very numerous spiral cordlets (about 40 on the last whorl down to the periumbilical cord, compared to the 12 present in *C. robusta* n. sp.); the axial sculpture can only be appreciated on the first teleoconch whorl: the umbilicus is wider while it is almost absent in *C. robusta* n. sp.; the periumbilical cord is not so wide and it is more separate from the umbilicus; the protoconch is smaller (360 µm compared to the 460 in *C. robusta* n. sp.).
Crossolida papuaensis n. sp. has an umbilicus but small; the periumbilical cord is a little narrower; the thickening of the outer lip is not so strong; the spiral

sculpture is finer, and consequently there are more cords (14-15 cords compared to the 12 of *C. robusta* n. sp.); the diameter of the protoconch is smaller (320 µm compared to the 380 of *C. robusta*).
Crossolida marquesensis, described and figured in Rubio, Rolán & Letourneux (2017) has more spiral cords (about 21 compared to the 12 of *C. robusta* n. sp.); the axial sculpture is very evident with numerous prosocline axial riblets which cross or almost cross the spiral cords. The protoconch has a prominent apical carinae and the sculpture is formed by smaller irregular tubercles. The periumbilical cord has spiral sculpture. The microsculpture between de spiral cords is very different to any other species (see below).

Etymology. The specific name alludes to the robust aspect of the shell.

Crossolida satispiralis n. sp.
Fig. 28A-F

Type material. Holotype MNHN-IM-2000-34444 (Fig. 28A-B).

Type locality. Vanuatu, 14°52'S-167°18'E, 1550-1620 m (MUSORSTOM 8: CP1109).

Material examined. MUSORSTOM 8, stn CP1109, 1 s, Vanuatu, 14°52'S-167°18'E, 1550-1620 m.

Description. Shell small (<2 mm), trochiform, with about 3 whorls, strong, with an elevated apex. Protoconch wide formed by little more than 1 whorl, with a nucleus of about 100 µm and a diameter of 360 µm; its surface is covered by large tubercles which are more dense in the middle where they are fused forming like a central elevation.
The teleoconch is formed by little more than 2 whorls with a rapid increase in diameter, convex and spirally sculptured. The first whorl has 7 spiral cords, wider than their interspaces in which there are numerous axial ribs; the second whorl is formed by about 43 very fine spiral cordlets separated by a fine groove and with very irregular and fine cordlets at each side; this part finishes on the periumbilical cord, which is wide, prominent and also sculptured with about 10 spiral cordlets. These cordlets are crossed by axial spiral riblets which penetrate into the umbilicus where there is a smaller periumbilical cord. The umbilicus is wide, limited by the columella which is curved and separated from the last whorl, and has two extensions corresponding to the points reached by the two periumbilical cords; the lower one is the most prominent. Aperture ovoid, with the upper part a little angled. Peristome smooth, a little extended in the outer lip and with an external thickening.
Dimensions: The holotype measures 1.58 mm in height and 1.28 mm in diameter (H/D = 1.23).

Habitat. Bathyal species dredged at 1550-1620 m deep.

Distribution. Only known from the type locality.

Remarks. *Crossolida satispiralis* n. sp. is characterized by its surface that, although looking smooth, presents a very fine spiral sculpture (about 40 cordlets on the last whorl); the umbilicus is evident; the periumbilical cord is wider and there is a second cord towards the inner part of the umbilicus.
By these characters it is easily differentiated from the other species of the genus.

Etymology. The specific name is formed by two Latin words: *satis,* which means "enough" and *spiralis* which is referred to the sculpture, which is very typical.

Crossolida papuaensis n. sp.
Fig. 29A-D

Type material. Holotype MNHN IM-2000-34582 (Fig. 29A-D).

Type locality. Papua New Guinea, Alexishafen, S Megas Islet, stn PD19, 05°05.4'S-145°48.5'E, 3-10 m (PAPUA NIUGINI: stn PD19).

Material examined. PAPUA NIUGINI, stn PD19, 1 s, Papua New Guinea, Alexishafen, S Megas Islet, 05°05.4'S-145°48.5'E, 3-10 m.

Description. Shell small (<2.5 mm), trochiform, with about 4 whorls, strong, with an elevated apex. Protoconch formed by about 1 whorl and eroded with a diameter of 320 µm.
The teleoconch is formed by about 3 whorls with a quick increase in diameter, convex and spirally sculptured. The first whorl has 5 spiral cords, wider than their interspaces, where there are numerous axial ribs; the second whorl has 7-8 spiral cords a little wider than their interspaces being smaller in the subsutural area. Also in these interspaces is evident the presence of very numerous and small axial ribs; in the last whorl, there are about 16-17 spiral flat threads separated by narrower grooves. The five threads on the subsutural part are more obvious and narrower, with deeper grooves between them; below, the cords are wider but less marked and only in the lower part the grooves are evident again but not at the end. In the lower part of the last whorl there are no axial ribs in the interspaces, but ovoid spaces in the narrow grooves between the cords. also decreasing to the lower part. Below these spiral cords, a wide prominent and axially striated cord can be seen around the umbilical area ending at lower part of the aperture like a prominence. The umbilicus is small and limited on

Figure 29A-E
Crossolida papuaensis sp. A-C. Holotype MNHN-IM-2000-34582, 2.13 mm in height, Papua New Guinea, Alexishafen, S Megas Islet, 05°05.4'S-145°48.5'E, 3-10 m; D. Protoconch; E. Sculpture.

its lower part by a second wide cord which ends in an expansion of the columella, which is curved; the aperture is ovoid with an angle in its upper part. The outer lip finishes in a narrow peristoma but is very thickened externally.
Dimensions: The holotype measures 2.13 mm in height and 1.8 mm in diameter (H/D = 1.18).

Habitat. Infralittoral species collected at 3-10 m deep.

Distribution. Only known from the type locality.

Remarks. *Crossolida papuaensis* n. sp. is characterized by its spiral sculpture which is less prominent in the middle of the last whorl where axial sculpture is absent.
It may be easily differentiated from the congeneric species: *Crossolida satispiralis* n. sp. has more spiral cordlets at the last whorl (about 43 vs about 14 in *C. papuaensis*) since those are very small.
Crossolida robusta n. sp. has less spiral cords on the last whorl, but here the axial sculpture is evident, the protoconch is wider and with many very small tubercles.

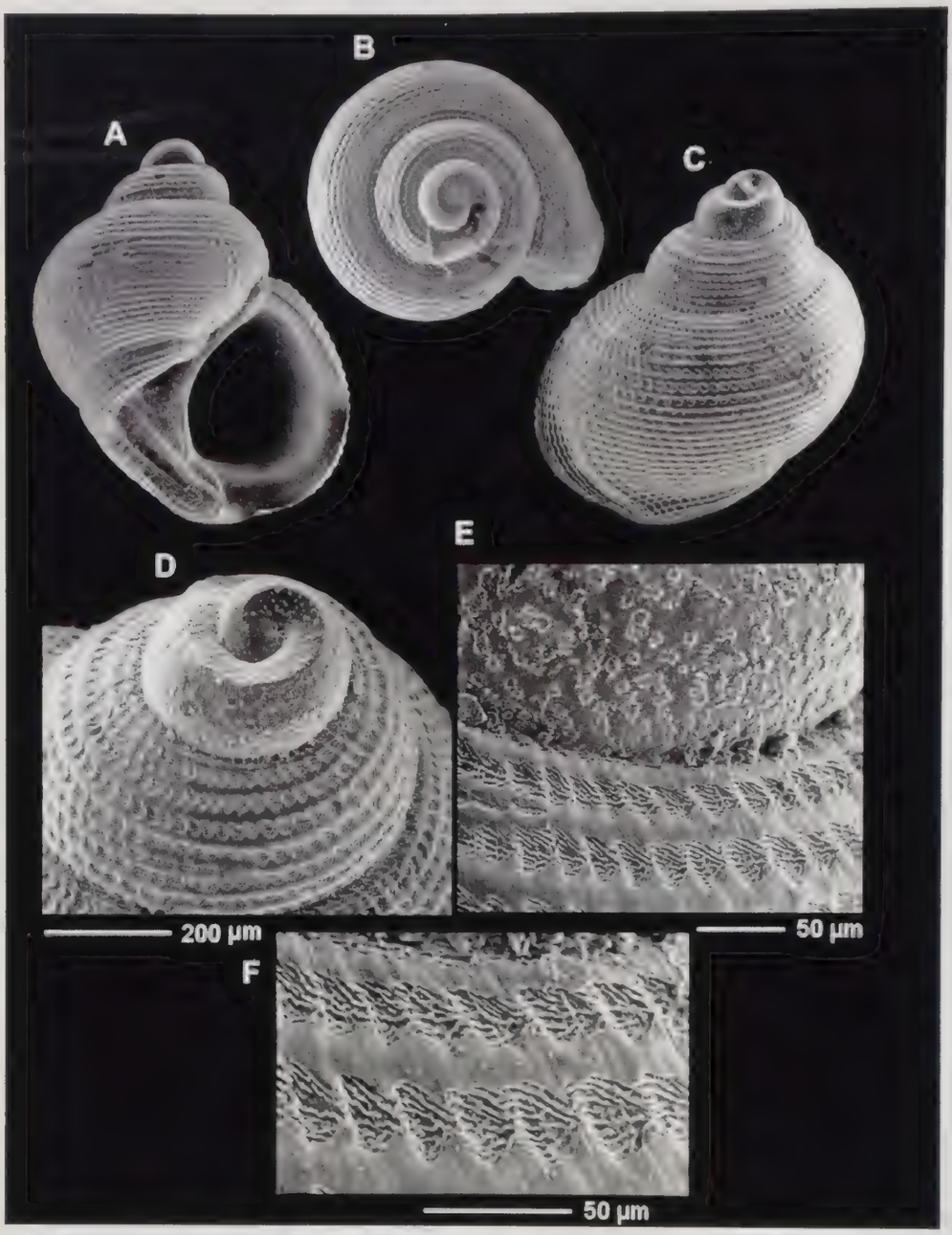

Figure 30A-F
Crossolida marquesensis (Rubio, Rolán & Letourneux, 2017). A-C. Holotype MNHN-IM-2000-32820, 1.5 mm in height, Marquesas Islands, Ua Pou I., Haakuti Bay, Pointe Punakukua, 68 m; D. Protoconch; E. microsculpture of the protoconch; F. microsculture of the teleoconch (figured in *Novapex* 18, fig. 3).

Crossolida marquesensis (Rubio, Rolán & Letourneux, 2017)
Fig. 30A-F

Crosseola marquesensis Rubio, Rolán & Letourneux, 2017: 22, fig. 3.

Type material. Holotype MNHN-IM-2000-32820; 2 paratypes MNHN-IM-2000-32821.

Type locality. Marquesas Is, Ua Pou Id, Haakuti Bay, Pointe Punahukua, 68 m.

Remarks. *Crossolida marquesensis* can be easily separated from the other species because of its very different microsculpture and the wide umbilicus. Originally, when the other now congeneric species had not been studied yet, this species was included in the genus *Crosseola*.
But now, after the description of the new genus, *Crossolida*, we have observed that this species adjust better to this last genus.

REMARKS AND CONCLUSIONS

In this second part of the revision of Indo-Pacific species of the family Conradiidae Golikov & Starobogatov, 1987, we have studied the genus *Crosseola* formed by 23 species, of which 3 were already known and 19 are new species. As a final addition, we have described a new genus in which one species was already known (although assigned to a different genus) and 3 more are described for the first time.

It is surprising (as it also occurred in the first part of this paper devoted to the genus *Crossea*) to see the small number of specimens collected during a large number of expeditions and hundreds of samplings carried out by the MNHN in collaboration with the IRD. As on the previous occasion, our belief is that there is a difficulty for the collection of abundant material due to the habitat in which the species of this genus live: in depth and in caves, and hidden places. This has been confirmed with the collaboration of the malacologist Sandro Gorí who put at our disposal material collected on many of his travels and in which he dived down to 30-40 m. In that material (also with isolated specimens) it was stated that on several occasions the collection was made in sediments found in underwater caves.

To resume, the depth of the material collected for the various species studied in this work was approximately within the following limits:

Genus *Crosseola*

- Between 1-3 m: no material.
- Between 4-20 m 1 species (*C. indigaxial*).
- Between 21-100 m: 4 species (*C. bellula, C. catenata, C. serrata, C. uniformis*).
- Between 101-300 m: 11 species (*C. foveolata, C. delicata, C. microstriata, C. sexlata, C. latumlabrum, C. distorta, C. dentata, C. intercalaris, C. prosoclina, C. osgrandis, C. minireticula*).
- Between 301-500 m: 7 species (*C. inverta, C. mayottensis, C. anodyna, C. benedotata, C. axialis, C. occlusa, C. escondida*).

Genus *Crossolida*

- Between 4-20 m 1 species (*C. papuaensis*)
- Between 21-100, 1 species (*C. robusta*)
- More than 1550 m, 1 species (*C. satispiralis*)

The difficulty of collecting specimens is demonstrated by the limited number of shells available for each species.

There was only one species for which 16 shells were available. For one species only 3 specimens have been obtained. For two species, two specimens/each have been studied. In the remaining species, only one shell per species was available for study.

Despite this small number of specimens there was no problem for their separation because in these genera there is an abundant amount of characters that allow separation: The diameter and the sculpture of the protoconch. The sculpture of the teleoconch whorls, the number of whorls, the periumbilical cord, the umbilicus, the size and shape, the columella, the aperture, the apertural edge, etc.

The geographical distribution of the studied material is as follows:

Seven species were collected in the Philippines, 3 in New Caledonia, 2 species were collected in: Maldives, Solomon, Fiji, Papua New Guinea, Vanuatu and French Polynesia. Only 1 species was collected in the following countries: Japan, Taiwan, South Africa, Mayotte and Mozambique.

Table 1. Detailed list of localities where the studied species were collected.

Crosseola bellula A. Adams, 1865	Japan
C. foveolata (Barnard, 1963)	South Africa
C. inverta (Hedley, 1907)	New Caledonia
C. escondida (Poppe, Tagaro & Goto, 2018)	Philippines
C. delicata n. sp.	Taiwan
C. mayottensis n. sp.	Mayotte
C. microstriata n. sp.	Fiji
C. latumlabrum n. sp.	Papua New Guinea
C. distorta n. sp.	Solomon
C. catenata n. sp	Philippines
C. dentata n. sp.	Philippines
C. anodyna n. sp.	Philippines
C. serrata n. sp.	Mozambique
C. indigaxial n. sp.	Maldivas
C. uniformis n. sp.	Maldivas
C. intercalaris n. sp.	New Caledonia
C. prosoclina n. sp.	Vanuatu
C. osgrandis n. sp.	Philippines
C. sexlata n. sp.	Philippines
C. benedotata n. sp.	New Caledonia
C. axialis n. sp.	Fiji
C. minireticula n. sp.	Philippines
C. occlusa n. sp.	Solomon
Crossolida robusta n. sp.	French Polynesia
C. satispiralis n. sp.	Vanuatu
C. papuaensis n. sp.	Papua New Guinea
C. marquesensis (Rubio, Rolán & Letourneux, 2017)	Marquesas Is.

Acknowledgements

Material in this paper mostly originates from deep water cruises conducted since 1977 by the MNHN and Institut de Recherche pour le Développement (IRD) as part of the *Tropical Deep-Sea Benthos* programme in the Philippines (MUSORSTOM 3), Taiwan and the South China Sea (TAIWAN 2001), Papua New Guinea (MADEEP), the Solomon Islands (SALOMON 1), New Caledonia (BATHUS 1 and 2), Vanuatu (MUSORSTOM 8), and Fiji (MUSORSTOM 10) (Principal Investigators: Jacques Forest, Bertrand Richer de Forges, Sarah Samadi, Tin-Yam Chan). For station lists and context of the expeditions, see https://expeditions.mnhn.fr/ and Bouchet *et al.* (2008). Additional sources are the 1977 BENTHEDI cruise in the Mozambique Channel (PI: Bernard Thomassin); Joseph Poupin's samplings in French Polynesia aboard RV *Marara* in 1991 (SMCB); and the PAPUA NIUGINI 2012 Madang expedition conducted by MNHN and Pro-Natura International (PNI) as part of the *Our Planet Reviewed* programme (PI: Philippe Bouchet). Scientific partners included National Taiwan Ocean University (NTOU, Keelung), University San Carlos (Cebu City) and the Bureau of Fisheries and Aquatic Resources (BFAR, Manila), and the University of Papua New Guinea (UPNG, Port Moresby), with access to ship time through the Flotte Océanographique Française. We thank Philippe Maestrati and his team of MNHN volunteers (Danielle Plaçais, Mauricette Bourgeois, Danièle Urban) for their sorting the molluscs from a vast amount of expedition material; Virginie Heros for checking carefully the manuscript and for management of registration numbers and locality data; and Manuel Caballer for the photo of the type of *Crossea bellula* under MNHN Projet RECOLNAT (ANR-11-INBS-0004). Finally, we would like to thank Philippe Bouchet for access to the malacological resources of the MNHN expeditions.

Also we thank to Sandro Gori, Italian malacologist, his cooperation giving material collected by himself and making donation of the holotypes to de MNHN.

To Marcos Andrés Gonzalez, Director of the Museo de Historia Natural of the University of Santiago de Compostela for the support in obtaining numerous SEM photographs necessary for this and other works. These photographs were made in cooperation with Jesús Méndez and Inés Pazos of the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo. Some others were made by Ramiro Barreiro and Raquel Antón Segurado in the Centro de Apoyo Científico y Tecnológico of the University of Santiago de Compostela (CACTUS).

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Idas cf. *cylindricus* Pelorce & Poutiers, 2009 (Bivalvia: Mytilidae) in Icelandic waters

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KEYWORDS. Bivalvia, Mytilidae, *Idas cylindricus*, Iceland

MOTS CLES. Bivalvia, Mytilidae, *Idas cylindricus*, Islande

ABSTRACT. A cetacean vertebra was collected during a campaign of the Marine and Freshwater Research Institute (Reykjavik - Iceland) in southwest Iceland. It was colonised by five specimens of the genus *Idas* Jeffreys, 1876 which have strong similarities with the species described as *Idas cylindricus* Pelorce & Poutiers, 2009. Illustrations and discussions about the identification are presented here.

RESUME. Une vertèbre de cétacé a été récoltée lors d'une campagne du "Marine and Freshwater Research Institute (Reykjavik - Iceland)" au sud-ouest de l'Islande. Elle était colonisée par cinq spécimens du genre *Idas* Jeffreys, 1876 qui présentent de fortes similitudes avec l'espèce décrite comme *Idas cylindricus* Pelorce & Poutiers, 2009. Leur appartenance spécifique est ici discutée, illustrations des spécimens à l'appui.

INTRODUCTION

The genus *Idas* Jeffreys, 1876 and *Adipicola* Dautzenberg, 1927 are assigned to Mytilidae Rafinesque, 1815 in the sub-family Bathymodiolinae Kenk & B.R. Wilson, 1985. There are discussions if these two genera should be considered as two different ones or only one genus (Warén 1991) but it is not the purpose to discuss this topic here.

The species of the genus *Idas* are found in association with organic material such as sunken wood or cetacean remains like sunken bones or "whale" blubber on which they feed with the help of chimiosymbiotic bacteria. The specificity of their habitats makes them difficult to find. Warén (1991) reviewed the species of the genus *Idas* in the European waters with a discussion on the genus *Adipicola* and *Myrina* H. Adams & A. Adams, 1854. Five species were identified at that time in the Northeast Atlantic Ocean (Atl.) and in the Mediterranean Sea (Med.): *Idas argenteus* Jeffreys, 1876 (Atl.), *Idas ghisottii* Warén & Carrozza, 1990 (Med.), *Idas modiolaeformis* (Sturany, 1896) (Med.), *Idas pelagica* (Forbes in Woodward, 1854) (Atl.) and *Idas simpsoni* (J.T. Marshall, 1900) (Atl. and Med.). Several new species were identified since then. Oliver & Holmes (2008) recognized in the North Atlantic *Idas argenteus* var. *lamellosus* Verrill, 1882 at the species level as *Idas lamellosus* Verrill, 1882. Pelorce & Poutiers (2009) described the new *Idas cylindricus* on a whale bone from the Gulf of Lion (Sète, South of France in the Mediterranean Sea). Since this description, Nolf & Kreps (2011) mentioned it in the Bay of Biscay, South of La Rochelle (France) on a sunken dolphin bone in association with *I. simpsoni*. All the collected specimens at this locality were juveniles. More recently, Giusti et al. (2012) added four new *Idas* species in the Mediterranean Sea from Tyrrhenian organic deep-water bottom: *Idas cristiani* Giusti, Mietto & Sbrana, 2012, *Idas emmae* Giusti, Mietto & Sbrana, 2012, *Idas filippoi* Giusti, Mietto & Sbrana, 2012 and *Idas jaclinae* Giusti, Mietto & Sbrana, 2012. This leads to a total of eleven species of *Idas* sensu lato in the European waters (MolluscaBase 2019). Finally, Scaperrotta et al. (2016) provided illustrations of growth series of Mediterranean species, with the exception of *I. cylindricus* already figured by Pelorce & Poutiers (2009).

The identification of the species is complicated by the fact that juveniles and adults do not always have the same shape and that, for some species, the teeth in the hinge present in juveniles disappear in adults. The size range proposed for each species must be considered as an indication only. Indeed, it happens that specimens illustrated by an author are in conflict with the size range they propose (Nolf & Kreps 2011, Scaperrotta et al. 2016). Furthermore, the scarcity of available specimens, mainly because of the specificity

of their living environment, means also that the distribution range for each species should be taken with caution.

Abbreviations

MFRI: Marine and Fresh Water Research Institute, Reykjavik, Iceland;
MNHN: Muséum national d'Histoire naturelle, Paris, France.

Material

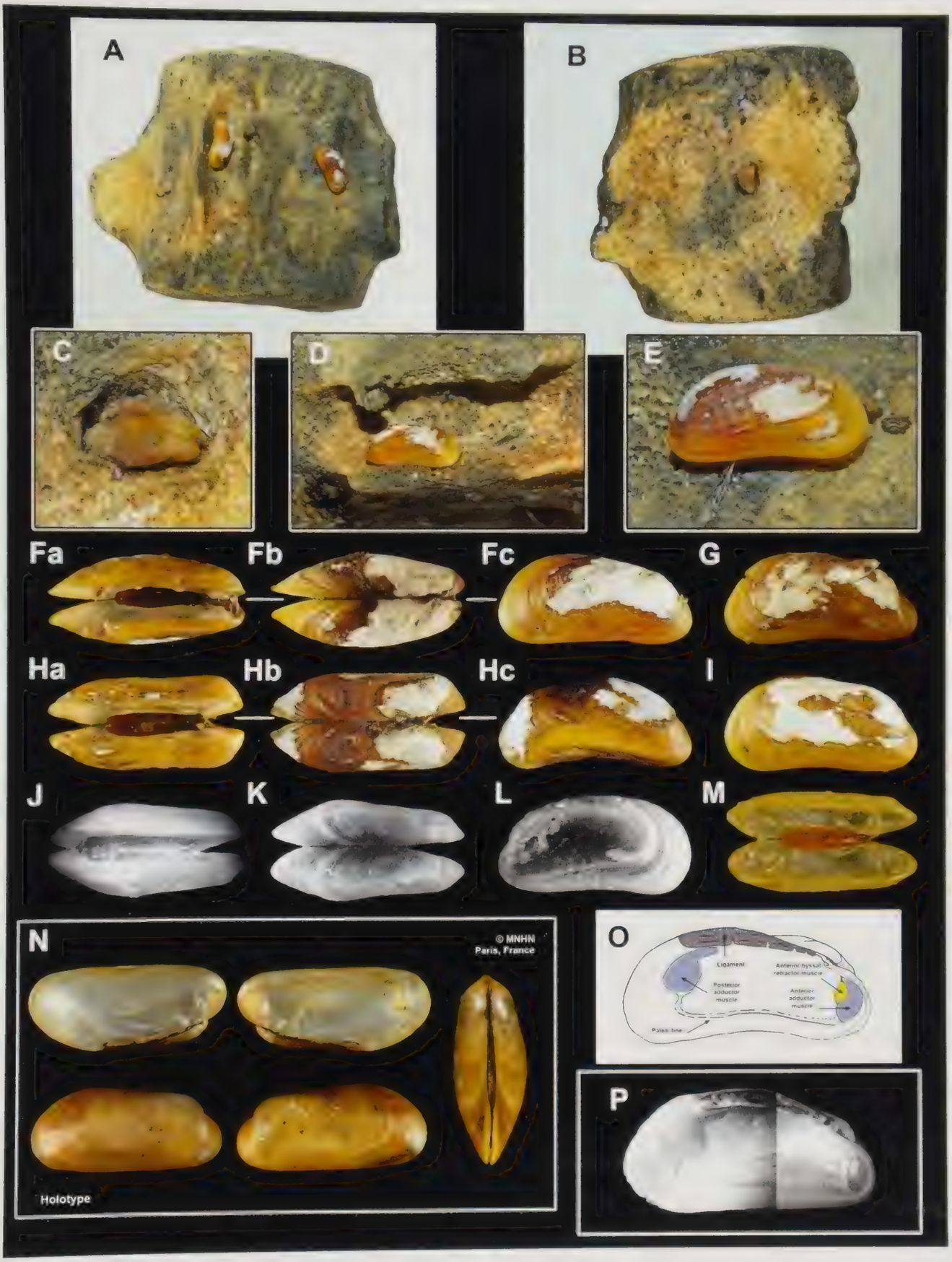
The Marine and Freshwater Research Institute in Reykjavik (Iceland) is conducting different campaigns in order to evaluate fish stocks each year. On May 19th 2014, a lumbar or anterior caudal vertebra of an Odontoceti was collected by Jónbjörn Pálsson at station D4-2014-53, net set at 63°27.56'N, 23°38.30'W at a depth of 188 meters; net hauled at 63°22.77'N, 23°42.15'W at a depth of 211 meters (southwest Iceland). The bone was kept in the deep freezer for a few months and analysed afterwards. The vertebra was about 9.5 cm long. It was colonised by five specimens of a Mytilidae of the genus *Idas*. When defrosted, three specimens were still in place (Fig. 1A), the two others had fallen off the vertebra. One of the specimens was fixed inside a foramen of the bone (Fig. 1B-C) and the others were attached on the bone by a small byssus of only a few threads (Fig. 1D-E).
All five specimens had more or less the same size (from 15.9 to 17.3 mm in length) and were adults. At first sight these specimens reveal a very inflated shell, a quite rectangular shape and a relatively big size for the genus.

COMPARATIVE ANALYSIS AND DISCUSSION

Compared to the five species present in the Northeast Atlantic so far, these Icelandic shells do not belong to *Idas pelagica* (Forbes in Woodward, 1854) today accepted as *Adipicola pelagica* (Forbes in Woodward, 1854), their umbos being situated very anteriorly, nor to *I. argenteus* and *I. lamellosus* due to their size and shape. The big size of the Nordic shells is in accordance with *I. cylindricus* and *I. simpsoni*, two quite close species, but the rectangular shape (Fig. 1Fa-b, 1Ha-b) and the position of the umbos (Fig. 1Fc, 1G, 1Hc, 1I) make them closer to *I. cylindricus* (Fig. 1L) than to *Idas simpsoni*.
Compared to the four species recently described in the Tyrrhenian Sea (Giusti et al. 2012) and to the Mediterranean species *I. ghisottii*, the rectangular and cylindrical shape of the Icelandic specimens is completely different from the elongated form of the last described Mediterranean species. Moreover, unlike the latter, their periostracum is devoid of bristles. *Idas modiolaeformis* presents a short and thin ligamentous area while the one of *I. cylindricus* and Icelandic specimens is long and thick (Fig. 1Fa, 1Ha), even in young specimens as observed on individuals in our possession from the Gulf of Biscay (Fig. 1M). Furthermore, as far as known from the literature, the habitat of *I. modiolaeformis* appears to be limited to deep water organic bottoms in the Mediterranean (Scaperrotta et al. 2016, Warén 1991). Records on cetacean bones are up to now unknown for this species.
Compared to *I. cylindricus*, the umbos of the Icelandic specimens are well located in the anterior part of the shell and the hinge is also very large. Because their umbos are all worn out (Fig. 1Fb, 1Hb) and as a consequence the prodissoconchs are no longer visible, it is impossible to compare them with those of *I. cylindricus* at the source of the original description (Pelorce & Poutiers 2009). In adult specimens of *I. cylindricus* the length (L) / height (H) ratio is close to 2.20. It varies between 2.05 and 2.28 for the five Icelandic shells. Beyond 15-17 mm, the height of the valves of *I. cylindricus* is almost equal to their bulge, which gives to the larger specimens their distorted appearance exactly like in the Icelandic shell (Fig. 1F-I, 1K) although their ventral edge is a little bit more arched. Even in this case the dorsal and ventral edges of the shells remain almost parallel. As can be seen by comparing the profile of the holotype (Fig. 1N) with the one of paratype 3 and other paratypes represented

Figure 1

A-I. *Idas* cf. *cylindricus*, southwest Iceland, MFRI. A-B. Odontoceti vertebra of 9.5 cm long with the three *Idas in situ*. C. Specimen 5 into the foramen of the bone. D-E. Specimens 1 and 4 fixed by their byssus on the surface of the bone. Fa-c. Specimen 1: 17.3 mm x 7.6 mm. G. Specimen 2: 17.3 x 8.2 mm. Ha-c. Specimen 3: 15.9 x 7.4 mm. I. Specimen 4: rigth valve, 16.2 x 7.9 mm.
J-N. *Idas cylindricus*. J. Paratype 13 in Pelorce & Poutiers 2009, 23.0 x 10.3 mm. K. Paratype 2 in Pelorce & Poutiers 2009, 17.2 x 8.1 mm. L. Paratype 3 in Pelorce & Poutiers 2009, 12.3 x 6.7 mm. M. Off south La Rochelle - Bay of Biscay, France, 180 m on dolphin bone, 4.3 x 2.0 mm. N. Holotype MNHN-IM-2000-20793, off Sète, Mediterranean Sea, Gulf of Lion, Hérault, France, 42°-43°N, 03°-04°E, 15.6 x 6.4 mm.
O. *Idas* cf. *cylindricus*, drawing of the internal face of the left valve, specimen 4, 16.2 x 7.9 mm.
P. *Idas cylindricus*, internal face of paratype 11 in Pelorce & Poutiers 2009, 15.0 x 7.0 mm.


A
B
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Fa
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Hb
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K
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M
N
© MNHN
Paris, France
Holotype
O
Ligament
Anterior byssal retractor muscle
Posterior adductor muscle
Anterior adductor muscle
Palea line
P

in Pelorce & Poutiers (2009: 982, fig. 3) all of them have a different shape. Moreover, the holotype is not particularly the most representative specimen of the series. The internal surface of the left valve of an Icelandic specimen is represented by a drawing in Fig. 1O. The anterior adductor muscle scar (AAS) forming ¾ of a circle is large and goes far into the anterior part of the shell (Fig. 1O). The umbos are positioned slightly at the edge of the AAS, whereas it should be located at the vertical of its middle part as specified in the description of *I. cylindricus*. Considering the case of *I. simpsoni* in which the umbos are far distant from the AAS (Pelorce & Poutiers 2009), this element excludes the Icelandic specimens from belonging to this latter species. The most striking comparative feature is the very strong and large brown internal ligament which occupies more than half of the shell (Fig. 1Fa, 1Ha, 1J, 1M, 1O). The byssus is very weak, made of a few threads (Fig. 1E), a characteristic which is in accordance with the description of that of *I. cylindricus*.

CONCLUSIONS

The very long and large brown internal ligament, the large hinge, the rectangular form of the shells, the deformed valves when bigger than 15 mm, the absence of bristles on the periostracum, the weak byssus, the ratio L/H close to 2.20, are all features well in accordance with *Idas cylindricus*. The position of the umbos in relation to the AAS being not fully in accordance with the holotype/paratypes of *I. cylindricus* leads us to a determination as *Idas* cf. *cylindricus*. The availability of more specimens with undamaged umbos and showing a wider variation range in size, shape and age would have brought more arguments for attributing these specimens to *I. cylindricus* or to another not yet described species. Since 2014, despite five years of dredging campaigns, no new *Idas* showed up in Icelandic waters, these molluscs were only found once. In the absence of such elements it is more reasonable, for the moment, to stick to *Idas* cf. *cylindricus* than to attempt to describe a new species.

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Description of *Chicoreus* (*Triplex*) *franzettiae* n. sp. (Gastropoda: Muricidae) from the Philippine Islands

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KEYWORDS. Philippine Islands, Gastropoda, Muricidae, *Chicoreus* (*Triplex*), new species,

ABSTRACT. A new species of *Chicoreus* (*Triplex*) Perry, 1810 is described from Siargao Island in the Philippines. It is compared with *C.* (*T.*) *banksii* (Sowerby II, 1841), *C.* (*T.*) *strigatus* (Reeve, 1849), *C.* (*T.*) *paini* Houart, 1983 and young specimens of *C.* (*T.*) *microphyllus* (Lamarck, 1816) which also occur in the Philippines or nearby areas.

RESUME. Une nouvelle espèce appartenant au sous-genre *Chicoreus* (*Triplex*) Perry, 1810 est décrite de l'Ile Siargao aux Philippines. Elle est comparée à *C.* (*T.*) *banksii* (Sowerby II, 1841), *C.* (*T.*) *strigatus* (Reeve, 1849), *C.* (*T.*) *paini* Houart, 1983 et à de jeunes *C.* (*T.*) *microphyllus* (Lamarck, 1816) également présents aux Philippines ou dans les régions avoisinantes.

INTRODUCTION

The genus *Chicoreus* was divided into four subgenera by Houart (1992) as *Chicoreus* s.s., *Chicoreus* (*Triplex*) Perry, 1810, *C.* (*Rhizophorimurex*) Oyama, 1950 and *C.* (*Chicopinnatus*) Houart, 1992.

Chicoreus (*Triplex*) is the subgenus with by far the highest number of living species, estimated at up to 61 by Houart (2018). Of those, most live throughout the Indo-Pacific while 15 occur also in the Philippines (Houart, 2008a). Since then, a single species was added from the Philippines by Houart (2008b).

Material and methods

Material

The shells were collected by fishermen in the Philippines. Eight specimens were examined by the author as well as images of additional material in the J. P. Barbier collection.

Methods

The characters used to describe shell morphology address the general aspect of the shell, its shape, size, and colour, the shape of the spire including the number and features of the teleoconch whorls, details of the suture and of the subsutural ramp, details of axial and spiral sculpture, the aperture, the siphonal canal and the operculum. The description is based on the type material.

Abbreviations

Terminology used to describe the spiral cords and the apertural denticles (after Merle 2001 and 2005) (Fig. 1B).

Convex part of teleoconch whorl and siphonal canal

ab: Abapical (or abapertural); abis: Abapical infrasutural secondary cord (on subsutural ramp); ABP: Abapertural primary cord on the siphonal canal; abs: Abapertural secondary cord on the siphonal canal (between ABP and MP); ad: Adapical (or adapertural); adis: Adapical infrasutural secondary cord (on subsutural ramp); ADP: Adapertural primary cord on the siphonal canal; ads: Adapertural secondary cord on the siphonal canal; IP: Infrasutural primary cord (primary cord on subsutural ramp); MP: Median primary cord on the siphonal canal; ms: Median secondary cord on the siphonal canal; P: Primary cord; P1: Shoulder cord; P2-P6: Primary cords of the convex part of the teleoconch whorl; s: Secondary cord; s1-s5: Secondary cords of the convex part of the teleoconch whorl (example: s1 = secondary cord between P1 and P2; s2 = secondary cord between P2 and P3, etc.).

Aperture

D1 to D5: abapical denticles;
ID: Infrasutural denticle.

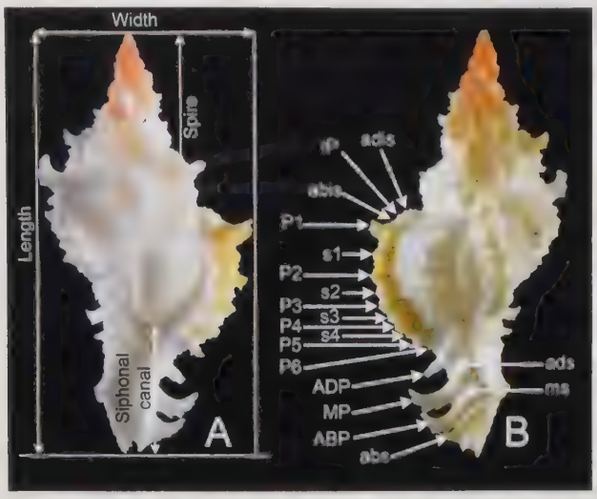

Figure 1
A. Selected measurements.
B. Spiral sculpture

SYSTEMATICS

Family Muricidae Rafinesque, 1815
Subfamily Muricinae Rafinesque, 1815
Genus *Chicoreus* Montfort, 1810
Subgenus *Triplex* Perry, 1810
Type species by monotypy: *Triplex foliatus* Perry, 1810 (= *Murex palmarosae* Lamarck, 1822), Indo-West Pacific.

Chicoreus* (*Triplex*) *franzettiae n. sp.
Figs 1, 2A-F

Type material. Holotype Muséum national d'Histoire naturelle, Paris, France, MNHN-IM-2000-35027, 2 paratypes R. Houart, 5 paratypes J.P. Barbier.

Type locality. Philippine Islands, Siargao Island, Dapa area, by tangle nets around 30 to 40 meters.

Distribution. To date, known only from the type locality.

Description. Shell small for the subgenus, up to 42.7 mm in length (paratype J.P. Barbier). Length/width ratio 1.84-2.00. Slender, lanceolate, fragile, weakly spinose and nodose. Subsutural ramp narrow, weakly sloping, lightly convex. Shell entirely white or light orange, occasionally with light orange varices or with blackish brown coloured primary cords, apex and first teleoconch whorls pink. Aperture white.
Spire high with protoconch of undetermined nature, eroded in all examined specimens, up to 8 weakly convex, elongate, very weakly shouldered, nodose teleoconch whorls. Suture of teleoconch whorls impressed.
Axial sculpture of teleoconch whorls consisting of varices and intervarical nodose ribs. Each varix with short or very short, lightly frondose, narrow, open primary spines. Adapical spine extending from P1 spiral cord longest. Spines decreasing in length abapically. Each teleoconch whorl with 3 varices and 2 nodose ribs between each pair of varices from third or fourth whorl, preceding whorls with 1, 2 or rarely 3 intervarical ribs. Spiral sculpture of low, rounded, narrow, primary, secondary and tertiary cords. Last teleoconch whorl with adis, IP, abis and tertiary cords on subsutural ramp, followed by P1 to P6, s1-s5 secondary cords and several narrow tertiary spiral cords on convex part of teleoconch whorl. P1-P5 approximately of same strength, P6 very narrow. Siphonal canal with ADP, ads, MP, ms, ABP, abs. ADP-ABP primary cords giving rise to fairly long, adapically recurved, frondose spines. MP spine longest.
Aperture moderately large, ovate. Columellar lip narrow, almost completely weakly erect except on small portion adapically, smooth and with strong, narrow parietal tooth at adapical extremity. Anal notch deep, moderately broad. Outer lip erect, denticulate, with moderately strong, split, elongate denticles within: ID, D1-D5.
Siphonal canal moderately long, 29.8-33.0 % of total shell length, broad, dorsally bent at tip, narrowly open, with 3 frondose, short spines extending from ADP, MP and ABP spiral cords.
Operculum dark brown, ovate, with apical nucleus in lower right. Attached surface with about 14-17 growth lines and broad callused rim.

Remarks. *Chicoreus* (*Triplex*) *franzettiae* n. sp. may be compared with four more or less related species from the Philippines or from nearby localities, although several shell characters differentiate these from the new species.
Chicoreus (*Triplex*) *banksii* (Sowerby II, 1841), maybe the *Triplex* species with the most variable shell characters in the Philippines (Fig. 2G-M) differs in being constantly broader and larger compared with shells having the same number or fewer teleoconch whorls as in *C. franzettiae* n. sp. The shell ornamentation in *C. banksii* being highly variable regarding the length of spines and the intervarical axial sculpture, those characters have not been taken into account here. However, in addition to being larger and wider, *C. banksii* also differs in having a lower spire and a comparatively longer siphonal canal in all forms. Eight specimens of *C. banksii* selected for their different shape and length, taken from the 38 specimens from the Philippines in my research collection were compared, using selected measurements (Fig. 1A), with the eight examined specimens of the new species.
The length/width ratio is an average of 1.47 with a minimum of 0.98 and a maximum of 1.75 in the eight specimens of *C. banksii* compared to 1.94 (minimum of 1.84 and maximum of 2.00) in *C. franzettiae* n. sp. The length of the siphonal canal is an average of 39% of the total shell length in *C. banksii* (minimum of 33% and maximum of 44%) while it is an average of 31% in the new species (minimum of 30% and

Figure 2

A-F. *Chicoreus* (*Triplex*) *franzettiae* n. sp. Philippine Islands, Siargao Island, Dapa area, by tangle nets around 30 to 40 meters.
A-B. Holotype MNHN-IM-2000-35027, 36.2 mm; C-D. Paratype R. Houart, 40.0 mm; E-F. Paratype R. Houart, 36.6 mm.
G-M. *Chicoreus* (*Triplex*) *banksii* (Sowerby II, 1841)
G. Philippine Islands, Samal, Island, Birat, 100-200 m, 51.4 mm; H. Philippine Islands, Sulu Sea, Jolo Island, 65.2 mm; I. Philippine Islands, Tungkil Island, 57.8 mm; J. Indonesia, off Kalimantan, 130 m, 29.7 mm; K. Philippine Islands, Zamboanga, 68.3 mm; L-M. Philippine Islands, Zamboanga, 47.2 mm (all R. Houart coll.).
N-Q. *Chicoreus* (*Triplex*) *strigatus* (Reeve, 1849), Northern Taiwan Strait.
N-O. 35.3 mm; P-Q. 34.3 mm.
R-T. *Chicoreus* (*Triplex*) *paini* Houart, 1983, Palau Archipelago.
R. 38.5 mm; S-T. 43.0 mm.
U-V. *Chicoreus* (*Triplex*) *microphyllus* (Lamarck, 1816), Banda Sea, Moluccas, 32.7 mm (juvenile).
W-Z. *Chicoreus* (*Triplex*) *axicornis* (Lamarck, 1822), Papua New Guinea, Madang, Laing Island, Hansa Bay.
W-X. 38.1 mm; Y-Z. 36.0 mm
(G-Z: all R. Houart coll.)

maximum of 33%). Finally, the length of the siphonal canal compared to the height of the spire also differs in both species, an average of 93% of the height of the spire in *C. banksii* (minimum 79% and maximum of 109%) compared to 65% in *C. franzettiae* n. sp. (minimum of 58% and maximum of 76%).

Chicoreus (*Triplex*) *strigatus* (Reeve, 1849) (Fig. 2N-Q) also has a narrow shell with a high spire but the short varical spines are always more elaborate and squamous, especially obvious on the last teleoconch whorl varices; the aperture is usually narrower with a typical narrow and deep anal sulcus in all examined specimens as opposed to a broader and shallower sulcus in *C. franzettiae* n. sp. In addition, the last teleoconch whorl in *C. strigatus* almost consistently has 3 narrow intervarical ribs instead of two in the new species.

Chicoreus (*Triplex*) *paini* Houart, 1983 (Fig. 2R-T), close to *C. strigatus* but basically with a lower spire, longer spines and longer siphonal canal, differs also from *C. franzettiae* n. sp. in having a broader shell with longer, more elaborate varical spines, in having a lower spire, a comparatively longer siphonal canal and a deeper anal sulcus.

Juvenile specimens of *Chicoreus* (*Triplex*) *microphyllus* (Lamarck, 1816) (Fig. 2U-V) of the same length as adults of *C. franzettiae* n. sp. differ in having fewer teleoconch whorls, a narrower last teleoconch whorl, more numerous intervarical ribs, different, more squamous varical spines with long P5 and P6, a comparatively narrower aperture and a deeper anal sulcus.

Finally, small specimens of *Chicoreus* (*Triplex*) *axicornis* (Lamarck, 1822) with short spines (Fig. 2W-Z) differ in having a comparatively longer siphonal canal, a narrower aperture, broader varices, a shorter spire and a different arrangement of the varical spines, in *C. axicornis* the P1 and P3 spines are obviously longer than the other ones.

Etymology. At his request, I am pleased to name this new species after Jean-Pierre Barbier's mother surname, Franzetti.

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I am very thankful to Jean-Pierre Barbier, The Philippines who kindly donated the type material and to John Wolff, Lancaster, Philadelphia, USA, for checking the English text and for other comments.

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SOCIETE ROYALE BELGE DE MALACOLOGIE

First record of *Calliostoma caroli* Dautzenberg, 1927 (Gastropoda: Calliostomatidae) alive in Icelandic waters

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KEYWORDS. Calliostomatidae, *Calliostoma caroli*, distribution, Iceland.

MOTS CLEFS. Calliostomatidae, *Calliostoma caroli*, distribution, Islande.

ABSTRACT. A live specimen of *Calliostoma caroli* Dautzenberg, 1927 was found at the depth of 1150 meters west of Iceland. This constitutes the first record for Icelandic waters. Together with the holotype described from the Azores (-1250 m) and the two records reported from the Reykjanes Ridge (-1125 m and -1170 m), this notification establishes for this Calliostomatidae a Northeast Atlantic range in deep waters around the Mid-Atlantic Ridge from Iceland to the Azores.

RESUME. Un spécimen vivant de *Calliostoma caroli* Dautzenberg, 1927 a été récolté par 1150 m de profondeur à l'ouest de l'Islande. Ceci représente la première signalisation dans les eaux islandaises. Ensemble avec l'holotype décrit des Açores (-1250 m) et les deux récoltes rapportées du Reykjanes Ridge (-1125 m et -1170 m), cette notification établit pour ce Calliostomatidae une aire de répartition nord-est atlantique, dans les eaux profondes aux abords de la dorsale médio-atlantique de l'Islande aux Açores.

INTRODUCTION

a) Deep water and Seamounts located *Calliostoma* in the Northeast Atlantic.

At the end of the nineteenth century and the beginning of the twentieth, multiple scientific cruises were conducted to inventory life on the seabed in the Northeast Atlantic Ocean and adjacent waters: "Travailleur" and "Talisman" expeditions 1880-1889, "Hirondelle" and "Princesse-Alice" expeditions 1888-1914 and others. Among the gastropods collected, many new species of *Calliostoma* Swainson, 1840 were found and subsequently described. Two came off Mauritania [*C. milneedwardsi* (Locard, 1898) and *C. triporcatum* (Locard, 1898)], one off Western Morocco [*C. maurolici* (Seguenza, 1876) (= *Gibbula obesula* Locard, 1898)], one from the Seine Seamount *C. lithocolletum* Dautzenberg, 1925 and six in the surroundings of the Azores [*C. caroli* Dautzenberg, 1927, *C. cleopatra* (Locard, 1896), *C. grimaldii* Dautzenberg & Fischer, 1896, *C. hirondellei* Dautzenberg & Fischer, 1896, *C. leptophyma* Dautzenberg & Fischer, 1896 and *C. normani* (Dautzenberg & Fischer, 1897)]. All were collected in the bathyal zone (between 454 and 2165 meters), with the exception of *C. lithocolletum* caught at shallower depth (185 m), at the top of the Seine Seamount in the northeast of Madeira and of *C. hirondellei* in the Azores, Strait of Pico - Fayal, collected at 130 m. One has to add to this group of shells *C. occidentale* (Mighels & C.B. Adams, 1842) which is probably the most commonly found species in the North Atlantic between 19 and 1000 meters deep (Graham 1988) and mentioned among others up to 1099 meters around the Faroe Islands (Sneli et al. 2005). On top of these "old" described species, Vilvens & Swinnen (2003) described *Calliostoma heugteni* from the Great Meteor Seamount at a depth of 340 meters (paratype 1 and 2) bringing the Northeast Atlantic species of *Calliostoma* to twelve. As reported in WoRMS, the depth and location of the holotype seem to be questionable (MolluscaBase 2019). Beck et al. (2006) extended the presence of *C. hirondellei*, *C. leptophyma*, and *C. lithocolletum* to the Seine, Ampère and Gettysburg Seamounts. Some mentions were made about *C. leptophyma* in the Banco de Galicia (Rolán & Suárez 2007), in Madeira (Segers et al. 2009) and in the Bay of Biscay (Le Duff 2015). Hoffman et al. (2011) published the presence of *C. cleopatra*, *C. leptophyma*, *C. maurolici* and *C. occidentale* in the Hatton and Rockall Banks. Vilvens & Swinnen (2017) described a thirteenth species *C. delonguevilleae* from the Gorringe Bank, off Sagres, West of Portugal. Among the *Calliostoma* species from the Iberian waters (including the Canary Islands), Gofas et al. (2017) listed *C. leptophyma*, *C. lithocolletum* and *C. maurolici*. Recently, Hoffman et al. (2019) reported specimens of *C. bullatum* (Philippi, 1844) alive off

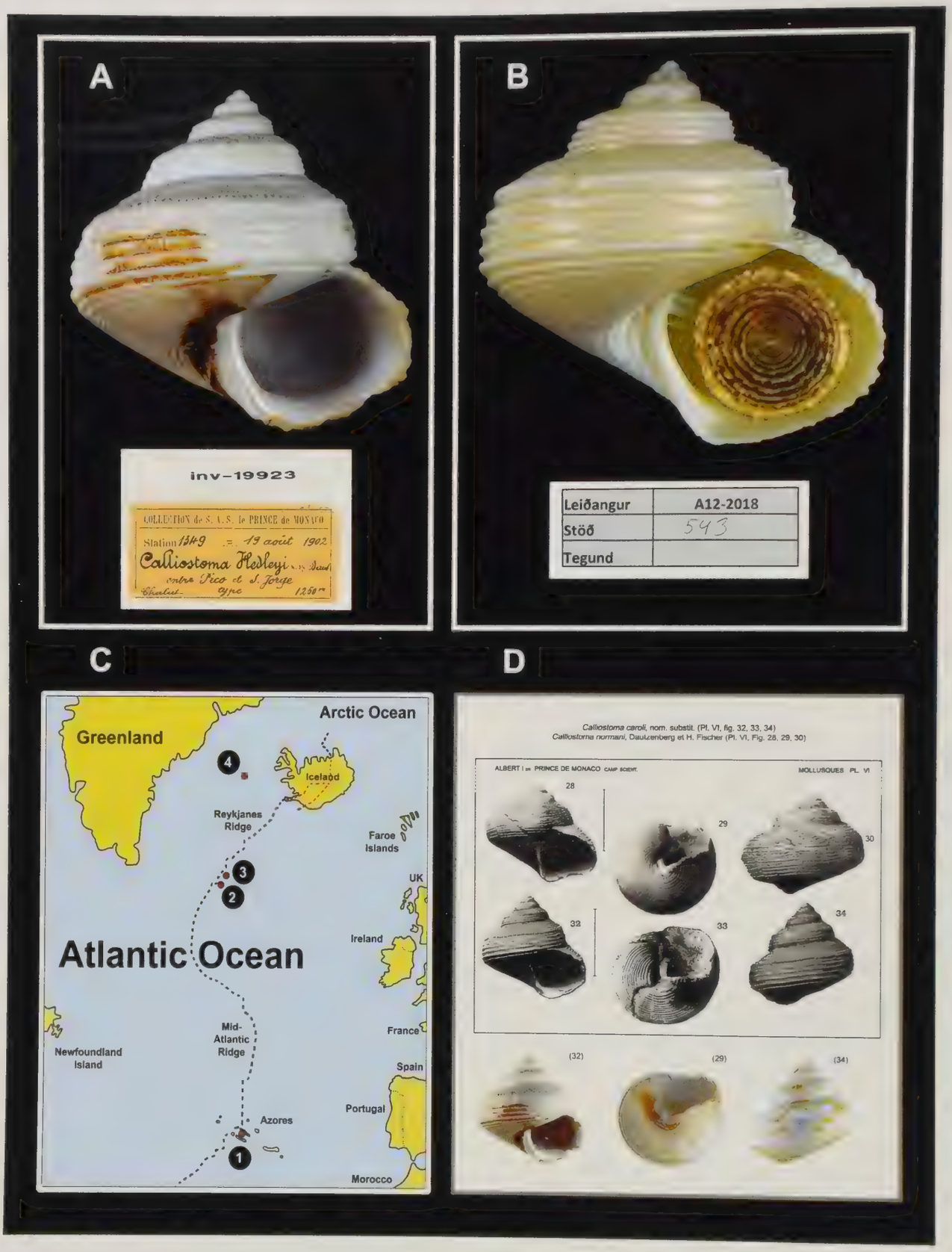

Figure 1

A-B. *Calliostoma caroli* Dautzenberg, 1927
A. Holotype, Oceanographic Museum of Monaco, INV-19923, shell 24.4 x 24.0 mm and original label; B. West Iceland, 26.3 x 27.8 mm and identifying working label.
C. Map showing localization of the records: (1) holotype from the Azores, (2) and (3) specimens from the Reykjanes Ridge, (4) specimen from West Iceland; **D.** Part of plate VI ex Dautzenberg (1927) with original positioning and numbering of *C. normani* (Dautzenberg & Fischer, 1897) and *C. caroli*; out of the box, representation as they should be.

Mauritania in deep water coral habitats (450-642 m depth), which brings the amount of Northeast Atlantic deep water and seamounts *Calliostoma* to fourteen. Before the discovery of these specimens *C. bullatum* was only known as fossil from Plio-Pleistocene deposits cropping out in the Messina and Reggio di Calabria area (Italy) (La Perna & d'Abramo 2010). Hoffman et al. (2019) reported also the wide distribution range of *C. maurolici* and *C. leptophyma* (live specimens for both up to 876 m depth) in DWC habitats [*Lophelia pertusa* (Linnaeus, 1758) and *Madrepora oculata* Linnaeus, 1758] in the Northeast Atlantic from the Rockall Bank in the north to off the continental slope of Morocco in the south and the Azorean Seamounts in the west. These two species are unknown from the Mauritanian slope. *C. bullatum*, *C. maurolici* and *C. leptophyma* were observed alive in their specific environment as confirmed by pictures taken by various Remotely Operated Vehicles.

b) *Calliostoma caroli* Dautzenberg, 1927

At the occasion of the 1902 scientific campaign of Prince Albert I of Monaco in the Atlantic Ocean, one empty specimen of *Calliostoma* was caught at a depth of 1250 meters on mud and volcanic sand between Pico and São Jorge (38°35'30" N, 28°05'45" W) in the Azores Archipelago (Figs 1A, C1) It was described by Dautzenberg (1925) and named *Calliostoma hedleyi*. Realising that this name was preoccupied by a *Calliostoma* from New Zealand (*Calliostoma hedleyi* Pritchard & Gatliff, 1902), Dautzenberg (1927) gave it the new name *Calliostoma caroli*. The original description mentions:
"Coquille solide, turbinée, imperforée, mais présentant, derrière le bord columellaire, un très léger sillon. Spire médiocrement élevée composée de 7 tours étagés dont 3 embryonnaires lisses et convexes, les autres traversés par une carène médiane, déclives au dessus de cette carène et descendant abruptement au-dessous. Dernier tour anguleux à la périphérie, ce qui rend son profil bianguleux. Surface des 4 derniers tours traversée par des cordons décurrents finement granuleux. On compte sur le dernier tour, au dessus de la carène, six cordons très rapprochés et au dessous 4 cordons plus espacés. La carène elle-même est accompagnée de deux cordons juxtaposés dont les granulations sont plus saillantes. Base convexe couverte d'une vingtaine de cordons concentriques aplatis, contigus et non granuleux. Ouverture arrondie-subquadrangulaire. Columelle peu épaissie, légèrement arquée. Labre arrondi à peine bianguleux. Coloration blanchâtre uniforme, à l'exception des tours embryonnaires qui sont luisants et nacrés, de même que le bord columellaire et l'intérieur de l'ouverture".

The shell is illustrated in Dautzenberg (1925: 3, fig. 12, frontal view) and in Dautzenberg (1927: pl VI, fig. 32-34, frontal, basal and dorsal views). However, in 1927 two photos are inverted (see further below). Finlay (1930), apparently not aware that Dautzenberg himself corrected the wrong name, renamed *Calliostoma hedleyi* Dautzenberg, 1925 as *Calliostoma dautzenbergi* Finlay, 1930 introducing thus a synonym to this new species. Since then nothing has been published concerning *C. caroli*, at the exception of a mention in Hoffman (2019) just to declare that this species has not been encountered in the DWC habitats in the NE Atlantic during their studies. A mention of the presence of *C. caroli* in the Black Sea, together with seven other Atlantic deep sea *Calliostoma* can be found in Teaca et al. (2016) without any supporting data. Consequently, it is difficult to consider this occurrence in the present distribution of *C. caroli*.

Abbreviations

DWC: Deep Water Coral.
GBIF: Global Biodiversity Information Facility.
MFRI: Marine and Fresh Water Research Institute, Reykjavik, Iceland.
SMNH: Swedish Museum of Natural History, Stockholm.
WoRMS: World Register of Marine Species.

Material

The Marine and Freshwater Research Institute in Reykjavik (Iceland) conducts campaigns each year in order to evaluate fish stocks around the country. On October 09th 2018 molluscs were collected during a trawl of the Research vessel "Árni Friðriksson" at station A12-2018-543, net set at 65°17.67'N, 28°31.10'W at a depth of 1150 meters; net hauled at 65°19.41'N, 28°28.73'W at a depth of 1148 meters (West Iceland) (Fig. 1C4), bottom temperature 4.1°C. Among other Gastropoda the sample contained 1 live specimen of *Calliostoma caroli*, height 26.3 mm, width 27.8 mm (Figs 1B, 2A-H, 5F-J). The operculum (Figs 1B, 2C) was in place on the animal and material was removed for genetic analysis.
The holotype of *C. caroli* was localized in the Oceanographic Museum in Monaco (INV-19923) and the specimen (24.4 x 24.0 mm) was kindly lent to us. Copies of the original labels were also provided (Figs 1A, 3D-E). On one of them written instructions from Dautzenberg's hand indicate how the photos should be taken for the 1927 publication (Fig. 3E). When in our possession, new shots were taken with modern equipment (Figs 1A, 3A-C, 3F-H, 5A-E). Comparing these photos with those of 1927 (Fig. 1D) force is to note that the shell was damaged because after being glued on a support it lost part of the outer layer from its dorsal surface as the result of old manipulations (Fig. 3B). This empty shell was taken at station 1349 on 19th August 1902 between Pico and São Jorge (Azores - 38°35'30" N, 28°05'45" W) during the cruise of "Le Prince Albert 1er de Monaco". In the Dautzenberg (1927) publication, the specimen had as

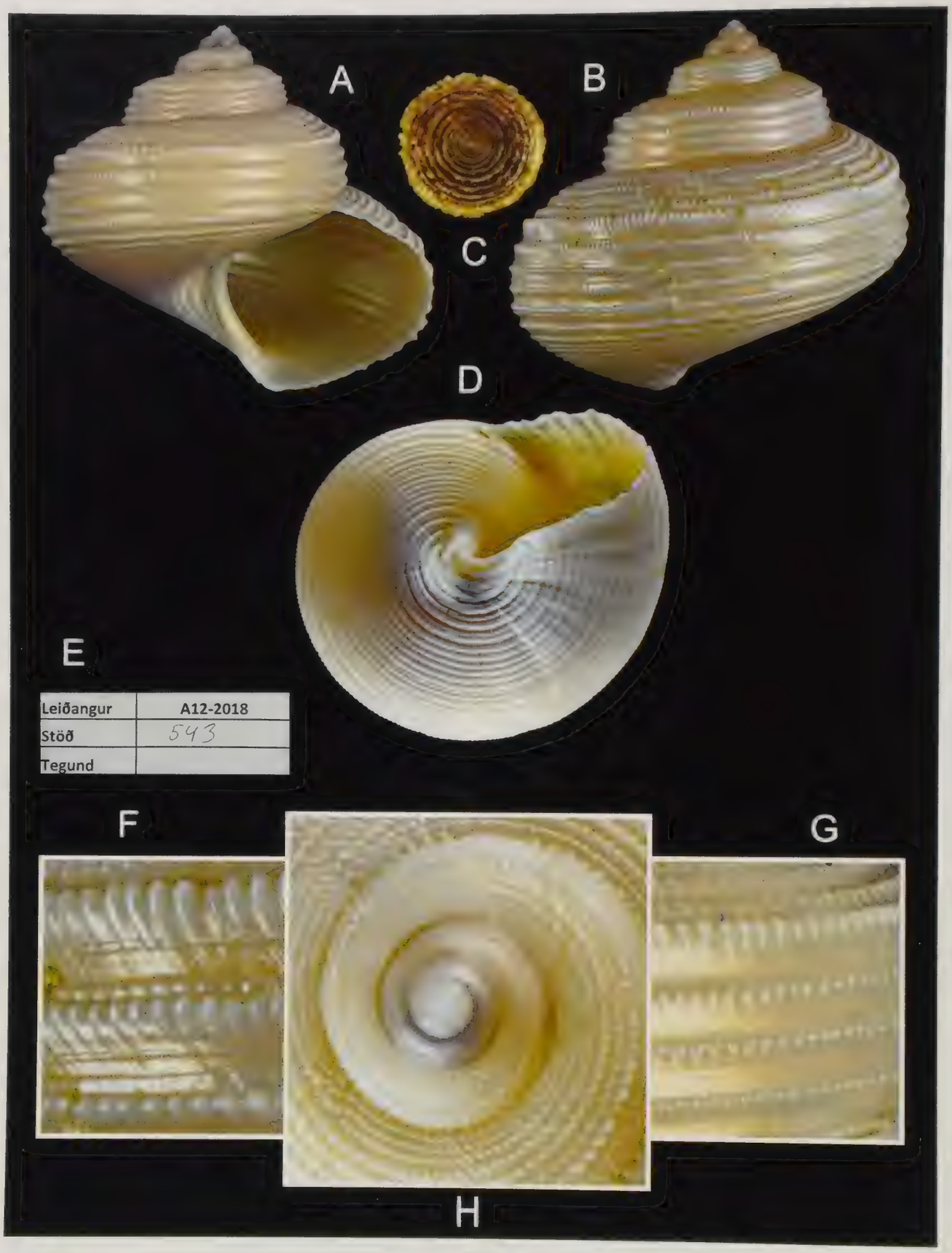

Figure 2

A-H. *Calliostoma caroli,* West Iceland, 26.3 x 27.8 mm.
A. Frontal view; B. Dorsal view; C. Operculum; D. Basal view; E. Working label; F. Detail of the microsculpture; G. Detail of the cord's arrangement; H. Upper view.

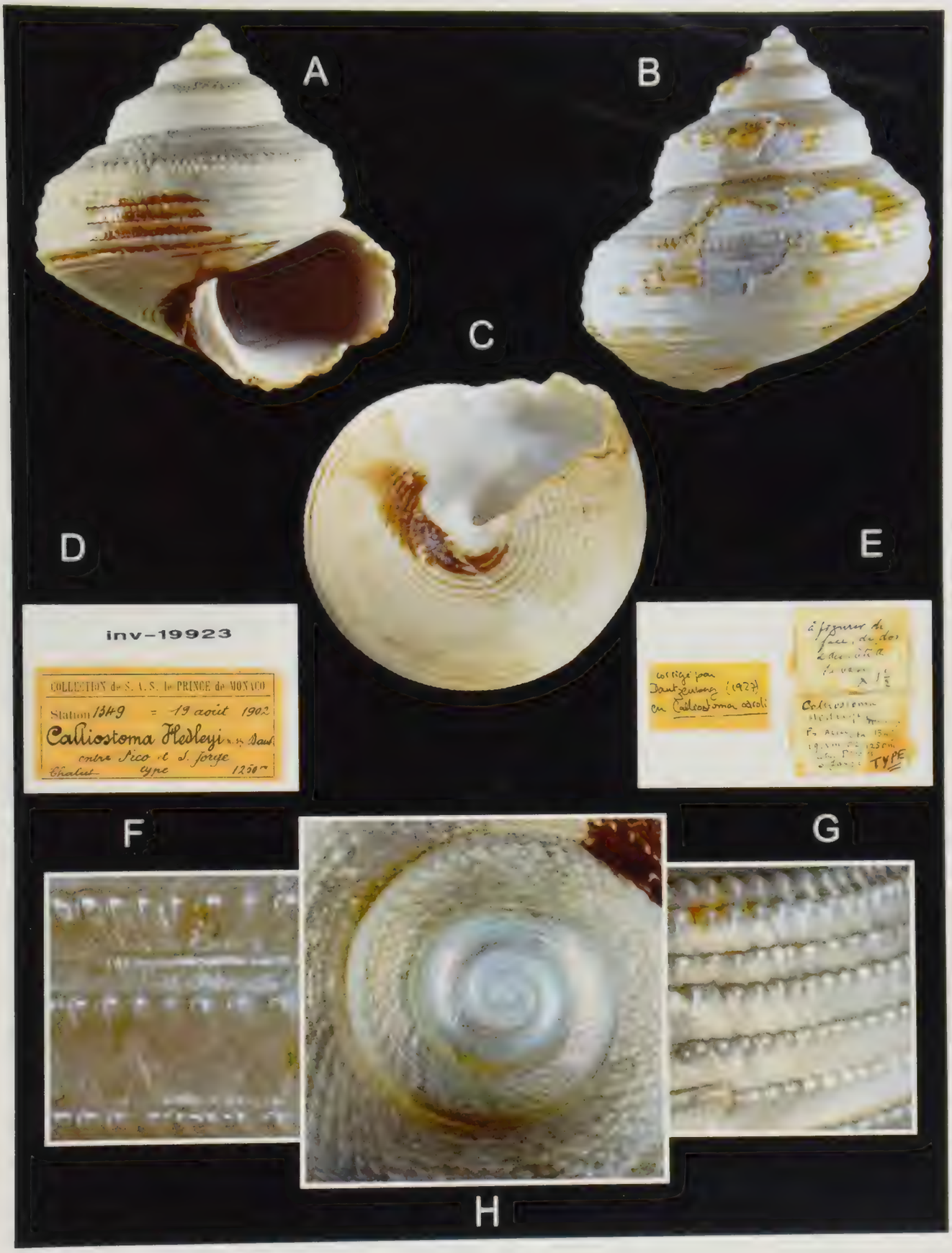

Figure 3

A-H. *Calliostoma caroli*, holotype, Oceanographic Museum of Monaco, INV-19923, shell 24.4 x 24.0 mm. A. Frontal view; B. Dorsal view; C. Basal view; D. Original label; E. Dautzenberg's hands instructions to the photograph for taking the photos; F. Detail of the microsculpture; G. Detail of the cord's arrangement; H. Upper view.

measures 25 x 25 mm. The original label refers to *Calliostoma hedleyi* and later a new label changed the specimen to *Calliostoma caroli*.

Consultation of the GBIF website (2019) revealed that two specimens of *C. caroli* were caught on the Reykjanes Ridge (North Atlantic Ocean) (Fig 1C2&3) in 1993 and kept at the SMNH of Stockholm. The specimens determined by Anders Warén were alive, shells and soft parts kept separately. The specimen SMNH 76365 (25.3 x 27.7 mm) caught at 1125m depth (59°2'12" N, 30°48' W) (Fig. 1C3), was localized in the collection of the Museum, and photos (Figs 4A-G, 5K-O) were provided to us by the Museum staff. The second specimen SMNH 76362 coming from 1170 m depth (58°33'12" N, 31°33'12" W) (Fig. 1C2) could not be traced back in the museum collection.

RESULTS, COMPARATIVE ANALYSIS AND DISCUSSION

A first observation was to realize that an error was introduced during the assembly of the plate VI in Dautzenberg (1927): the figure 33 meant to represent the base of *C. caroli* is that of a resembling species *C. normani* (shell slightly umbilicated) while figure 29 meant to represent the base of *C. normani* is that of *C. caroli* (shell not umbilicated). This inversion that had gone unnoticed until today could be the cause of confusion and misidentification. For the sake of accuracy, this leads us to say that in plate VI in Dautzenberg (1927) *C. caroli* is represented by the figures 32, 29 and 34 and *C. normani* by figures 28, 33 and 30 (Fig. 1D).

The newly provided photos of the *C. caroli* holotype objectify point by point the macroscopic characteristics identified by Dautzenberg in its original description (see above), namely the biangular profile of the post-embryonic whorls linked to the presence of a median carina formed of two granular juxtaposed cords delimiting above it a gently sloping surface which drops abruptly below it; the upper part of the whorls covered by 6 (to 8) very closely set together granulated cords and the descending part covered by 4 more spaced granulated cords; the convex base presenting only a very slight furrow at the base of the columella and covered with above 20 non-granulated flat concentric cords. Close-up shots of the holotype (Figs 3F-G, 5D-E) reveal the occasional presence of fine secondary cords on the descending part of the whorls and micro-sculpture made of thin prosocline striations that prolong and separate the elongated drop-like granules.

When comparing the mid-Atlantic shell from the SMNH with the *C. caroli* holotype one can identify a slight variation in the profile which is more rounded and less angulated (Figs 4A-B). This is probably due to the many growth accidents suffered by this specimen during its life. The same goes for the main cords that sometimes split and lose their continuity (Figs 4E-F, 5N-O).

By its frontal side the Icelandic specimen has a much more regular appearance than the mid-Atlantic one and appears to have undergone less breakage during its growth. Its profile is more in agreement with that of the holotype. It differs slightly in its carina which is not divided or only very slightly, as indicated by the presence of a weak secondary cord at the base of its granulated part when seen by its back side. In some places there are sometimes two juxtaposed cords which also have their origin in growths accidents, they do not necessarily extend over the entire surface of the whorl. The external surface of the specimen is pearly and in perfect condition and the internal part of the mouth shows also some iridescent reflects. New observations and pictures reveal the delicacy and regularity of the circular and vertical microsculpture that could only be guessed on the other two known specimens (Figs 2F-G, 5I-J).

All specimens were adult of very similar size, average height 25.3 mm, average width 26.5 mm.

CONCLUSIONS

The observation of the three specimens of *C. caroli* investigated here allowed to provide a modern iconography of the holotype, to identify an error in the plate VI in Dautzenberg (1927), to appreciate the variability of the profile and the arrangement of the circular cords imposed by shells growth accidents and to reveal the delicacy of the upper surface microsculpture. Even if great distances separate the collecting stations of these specimens, namely Azores, Mid-Atlantic Ridge and west of Iceland, and even if they differ by minor details in the sculpture or in the profile, they are overall very similar and belong to *Calliostoma caroli*. The vast area of distribution originates in the environmental conditions that are particularly constant at great depths. We can conclude that, until further discoveries, *Calliostoma caroli* has a Northeast Atlantic deep-sea distribution on and around the mid-Atlantic Ridge, from Iceland to the Azores.

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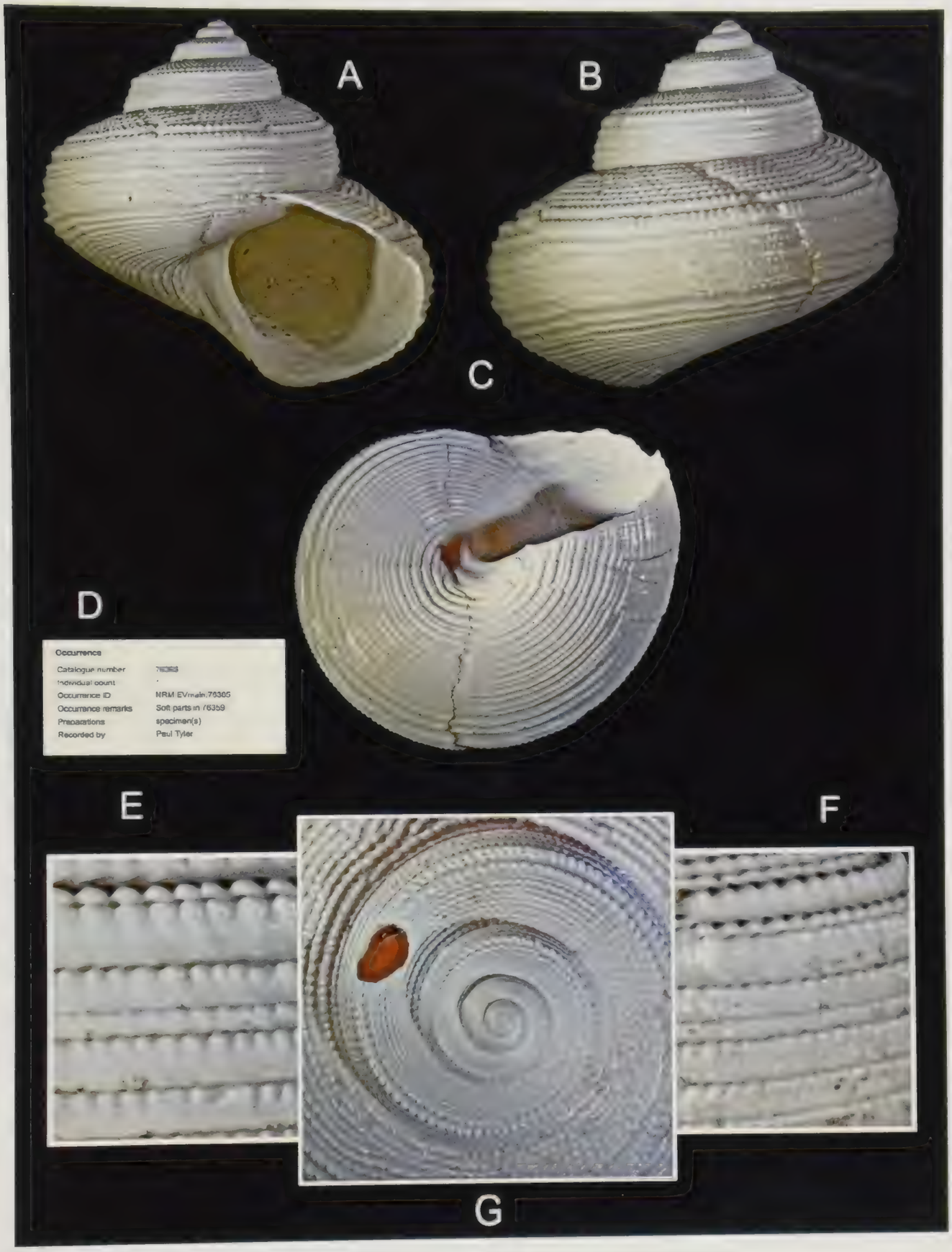

Figure 4

A-G. *Calliostoma caroli*, SMNH 76365, Reykjanes Ridge, 25.3 x 27.7 mm.
A. Frontal view; B. Dorsal view; C. Basal view; D. Sample identification information; E. Detail of the microsculpture; F. Detail of the cord's arrangement; G. Upper view.

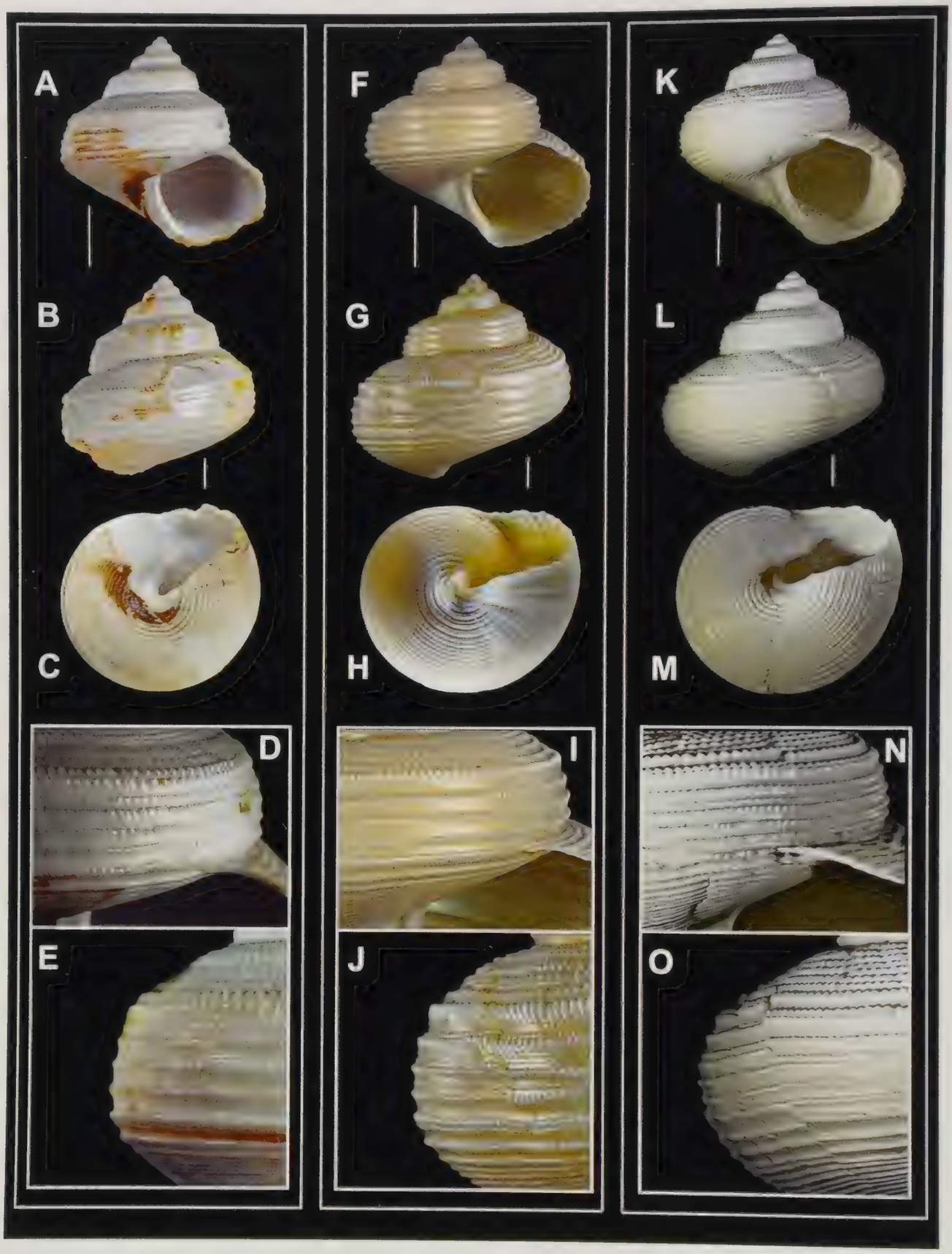

Figure 5

A-O. Comparative illustration of the three observed *Calliostoma caroli* specimens.
A-E. Holotype, Oceanographic Museum of Monaco, INV-19923; F-J. A12-2018-543, specimen from West Iceland; K-O. SMNH 76365, specimen from Reykjanes Ridge.

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Two new species of the skeneiform genus *Callodix* Laseron, 1954 from the Indian Ocean

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KEYWORDS. Gastropoda, Trochoidea, Skeneidae, *Callodix*, Indian Ocean, new species.

ABSTRACT. Two new species from the Indian Ocean are described in the skeneid genus *Callodix* Laseron, 1954. The new species are compared with the previously known *Callodix solida* Laseron, 1954 and *Callodix conica* Laseron, 1958. These two latter species are illustrated by photographs and also the new species by SEM micrographs. Data on habitat, bathymetry and geographic distribution of the new species are provided. At the same time, we here assign the previously described species *Anticlimax juanvianoi* Rubio & Rolán, 2018, *Anticlimax discus* Rubio & Rolán, 2014 and *Anticlimax religiosa* Rubio & Rolán, 2014 to *Callodix* and illustrate them.

RESUMEN. Se describen dos nuevas especies de skeneidos del género *Callodix* Laseron, 1954 procedentes del Océano Indico. Las nuevas especies se comparan con las especies previamente conocidas *Callodix solida* Laseron, 1954 y *Callodix conica* Laseron, 1958. Estas dos últimas especies, se ilustran mediante fotografías y las especies nuevas mediante micrografías obtenidas al MEB. Se aportan datos sobre hábitat, batimetría y distribución geográfica de las nuevas especies descritas. Al mismo tiempo se considera que las especies descritas previamente *Anticlimax juanvianoi* Rubio y Rolán, 2018, *Anticlimax discus*, Rubio y Rolán, 2014 y *Anticlimax religiosa* Rubio y Rolán, 2014, pertenecen a este género y se representan.

INTRODUCTION

Laseron (1954) created the genus *Callodix*, designing *C. solida* as the type species. He considered that it was probably related to *Teinostoma*, mainly due to the striated columellar callus that is extended on the umbilicus occluding it completely; however, he placed it in Liotiidae, with genera as diverse as *Liotina* Fischer, 1885, *Orbitestella* Iredale, 1917, *Cirsonella* Angas, 1877, *Lodderena* Iredale, 1924, *Brookula* Iredale, 1912 and *Pseudoliotia* Tate, 1898, as well as new genera of uncertain classification such as *Microcarina*, *Liocarina*, *Helisalia*, *Cavotera*, *Cavostella*, *Rotostoma* and *Wanganella*, amongst others.

Some of these genera currently remain in Liotiidae (*Liotina*), or are assigned to other families, such as Skeneidae (*Callodix*, *Liocarina*, *Rotostoma*, *Cirsonella*, *Lodderena*) (MolluscaBase 2019), an unassigned Seguenzioidea (*Microcarina*, *Wanganella*, *Brookula*), in Orbitestellidae (*Orbitestella*), or Vitrinellidae (*Pseudoliotia*).

Iredale & McMichael (1962) assigned *Callodix* to their new family Callomphalidae along with six other genus group names proposed by Laseron. However, this family name is invalid and not available because the authors provided no diagnosis.

There are already detailed reviews in the literature of the problems of classifying skeneiform gastropods. Ponder (many papers) has treated taxa that have been uncomfortably transferred from indeterminate vetigastropod ("skeneiform status") to indeterminate rissoidean Caenogastropod status or to heterobranch status. Ponder (1994) referred to a "vitrinellid-tornid assemblage".

Ponder & de Keyzer (in Beesley *et al.* 1998) in a comprehensive review of rissoidean families note that most available names are based on species that have not been collected alive and that without information on the animals their relationships will continue to be questionable. They regard Vitrinellidae as in "a state of taxonomic chaos" such that any discussion of even the genera present in Australia is premature.

It is important to mention that Takano & Kano (2014) in their molecular phylogeny show that

Tornidae is not monophyletic if it includes *Vitrinella* (*Vitrinella* is sister to *Iravadia*).

The molecular evidence confirms the earlier skepticism of monophyly by Ponder & de Keyzer (1998) in their review of Australian rissoidean family groups. It also supports the evidence from detailed study of live-collected animals of three anatomical characters separating Tornidae and Vitrinellidae as defined and discussed by Bieler & Mikkelsen (1988). Hickman & McLean (1990), Hickman (in Beesley *et al.* 1998), and Hickman (2013) have likewise treated Skeneidae as a large polyphyletic assemblage of genera (130 available genus-group names) that cannot be assigned under the restrictive radular and anatomical diagnosis of the family. *Callodix* has already been excluded from Skeneidae, but without reassignment, pending anatomical and/or molecular data.

In the meantime, we follow here the classification of MolluscaBase 2019. We decided simply to describe and to figure the existing species of *Callodix*, to describe two new species from Madagascar in this genus and to assign in *Callodix* our three species previously described under the genus *Anticlimax*.

MATERIAL AND METHODS

Our knowledge of the marine biodiversity of Madagascar is to a very large extent based on research carried in the regions of Nossi-Bé and Tuléar [Toliara], both located in the "Western and Northern Madagascar" marine ecoregion (Spalding *et al.* 2007) and characterized by extensive coral reefs ecosystems. By contrast, the "Deep South" of Madagascar is an oceanic region of fierce promontories, open bays and extensive algal belts. The lack of infrastructures has arguably made it the least visited and least known coastline in the country. The marine hydroclimate is characterized by a coastal upwelling with cold surface water and high concentrations of chlorophyll-*a* (Lutjeharms & Machu 2000), with winter sea surface temperatures as low as 21.5°C, vs 24-25°C or more elsewhere around Madagascar (Piton & Laroche 1993). From the late 1990's, new species of molluscs started to be discovered on the coastline of the regions Anosy and Androy, first serendipitously as a by-product of the local lobster fishery (e.g. Bouchet 1999), and later specifically attracting shell collectors and amateur taxonomists (e.g. Bozzetti 2006, 2008). These scattered findings and the unique oceanographic background together suggested that the "Deep South" of Madagascar had a potential for more discoveries, and this was what motivated a large-scale exploring expedition that sampled the benthos of the region in April-June 2010. The name of the expedition, *Atimo Vatae*, means "Deep South" in the regional Antandroy language. For base line information on the project, see http://laplaneterevisitee.org/en/87/accueil.

All materials used in the present study were obtained in sediments collected by the oceanographic expedition ATIMO VATAE (2012) doi.org/10.17600/10110040. Expedition to Madagascar "Deep South" marine fauna & flora, in shallow and deep waters off Madagascar.

In some stations, the material was obtained by dredging; the shells were separated under binocular set vision. For a more detail study, the scanning electron microscopy Quanta 200 was employed.

Abbreviations

AM: Australian Museum, Sydney;
ICZN: International Commission of Zoological Nomenclature;
MNHN: Museum national d'Histoire naturelle, Paris, France;
CACTI: Centro de Apoyo Científico y Tecnológico a la Investigación, University of Vigo, Spain;
Stn: Station;
S: empty shell;
WoRMS: World Register of Marine Species.

SYSTEMATICS

Superfamily **Trochoidea** Rafinesque, 1815
Family **Skeneidae** Clark, 1851
Genus ***Callodix*** Laseron, 1954
Callodix Laseron, 1954: 16, type species by original designation: *Callodix solida* Laseron, 1954 (Type locality: off Long Reef, Collaroy, Sydney N, NSW, Australia).

Diagnosis: "*Shell small and with a depressed spire, solid, few whorled, the sculpture fine concentric ridges, the aperture extended and very oblique, without a varix, the callosity on the base striated and greatly developed, forming not only the inner margin and covering the whole of the umbilical area, but extending above the aperture on to the body whorl, where it partially obscures the suture*" (Laseron 1954).

Remarks. The species of *Callodix* present generic characters defined by Laseron (1958: 173) as follows:

1. Small, depressed shell with fine spiral sculpture.
2. Greatly developed striate callus covering the base and extending posteriorly above the aperture upon the spire.

They also present other morphological characters such as:

1. Protoconch sometimes partially covered by the following whorls.
2. Teleoconch totally covered with spiral cords and grooves in the interspaces, which are usually in zigzag.
3. Aperture very prosocline.

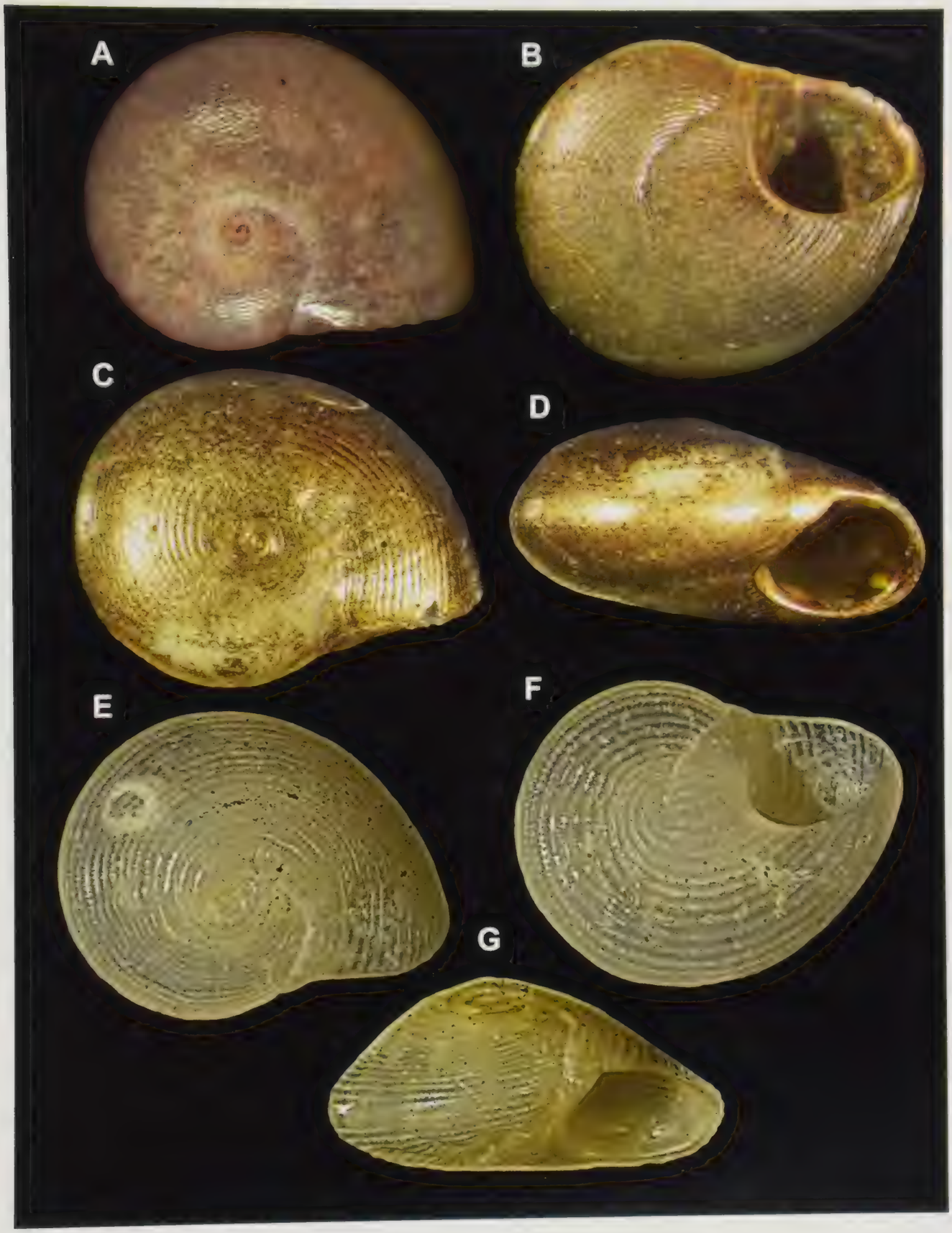

Figure 1
A-D. *Callodix solida* Laseron, 1954. A. Syntype AM C.102626, 2.38 mm in diameter; B-D. syntype AM C. 102626, 2.40 mm in diameter.
E-G. *Callodix conica* Laseron, 1958. Holotype AM C.102625, 1.72 mm in diameter.

In our opinion, and after examining the morphology of the studied species, we are using *Callodix* as stating a subjective judgment of the *concept* and not validity of the *name* in the nomenclatural sense of the ICZN. For morphological reasons we consider that the species *Anticlimax discus*, Rubio & Rolán (2014) (Fig. 4A-B), *Anticlimax religiosa* Rubio & Rolán (2014) (Fig. 4C-E) and *Anticlimax juanvianoi* Rubio & Rolán (2018) (Fig. 4F-G) should be placed in *Callodix*.

***Callodix solida* Laseron, 1954**
Fig 1A-D

Callodix solida Laseron, 1954: 16, fig. 25a-b.

Type locality. Off Long Reef, Collaroy, Sydney N, NSW, Australia.

Type material. 4 syntypes AM C.102626.

Remarks. According to the *Atlas of Living Australia* (ala.org.au), there are 51 lots for *Callodix solida* in the Australian Museum in Sydney; its geographical distribution is almost restricted to the Australian shores, having been found in the states of Western Australia, Queensland and New South Wales, however, among these, there are also two lots of French Polynesia, whose confirmation is pending.

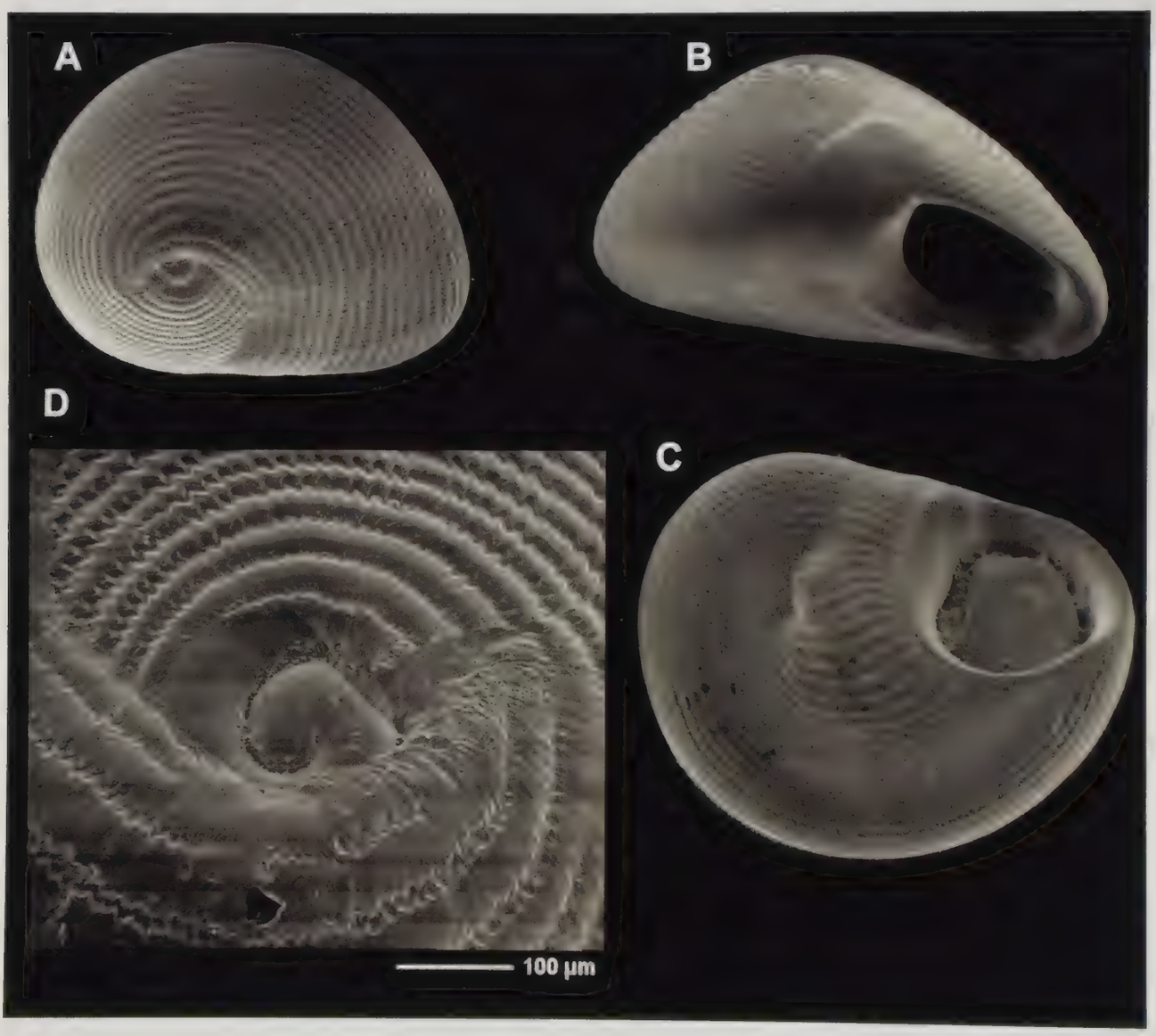

Figure 2
Callodix pseudoconica n. sp. **A-C.** Holotype MNHN-IM-2000-34585, 1.87 mm in diameter, South Madagascar, Libanona Beach, 25°02.5'S-46°59.7'E, 4-5 m, corallin rock bottom (ATIMO VATAE, stn TB07); D. Protoconch.

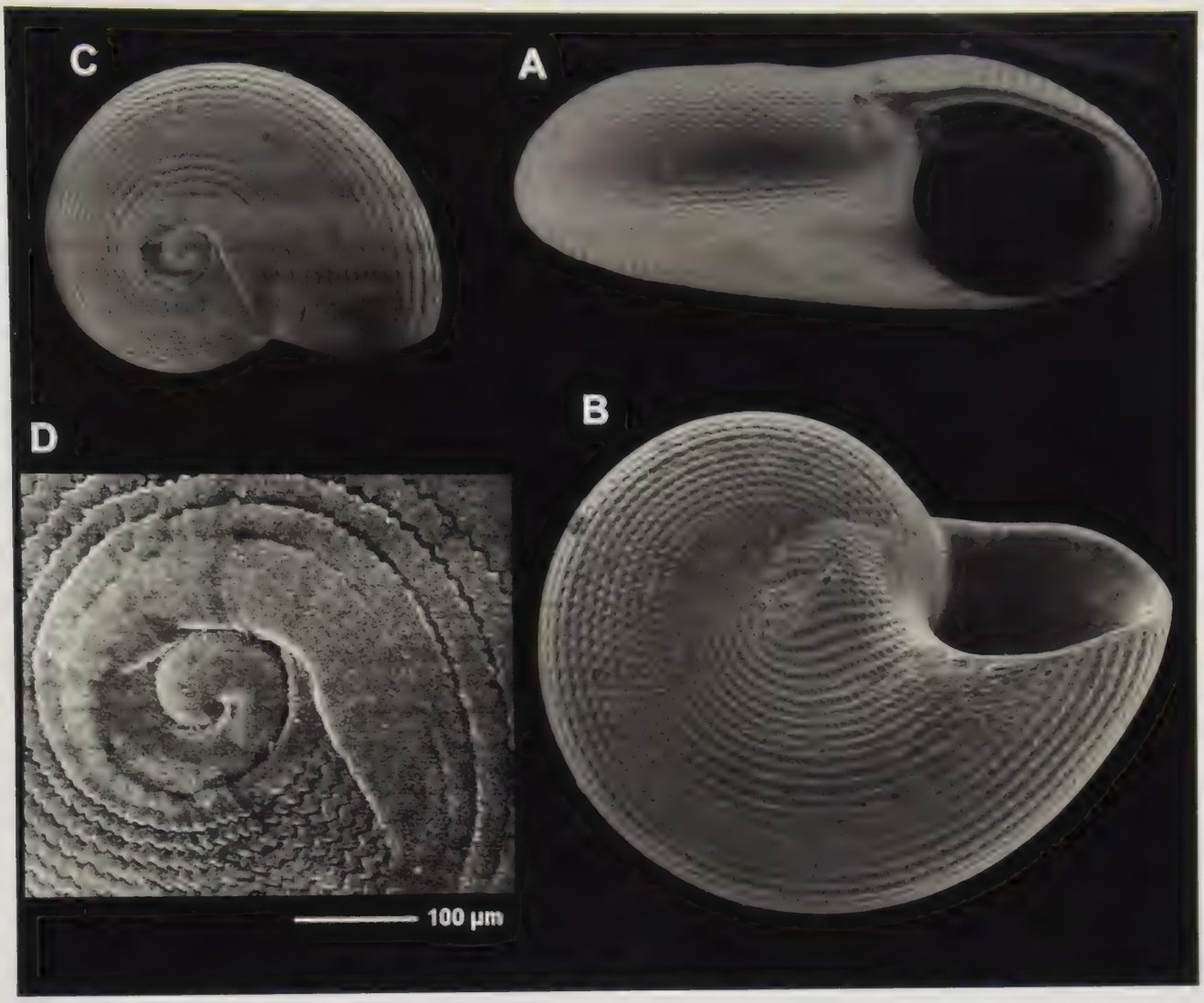

Figure 3
Callodix planata n. sp. **A-B.** MNHN-IM-2000-34587, 1.7 mm in diameter; **C.** paratype MNHN-IM-2000-34588, 0.95 mm; **D.** protoconch of the paratype.

Callodix conica Laseron, 1958
Fig. 1E-G

Callodix conica Laseron, 1958: 177, figs. 55-57.

Type locality. Darwin, Northern Australia.

Type material. Holotype AM C.102625.

Remarks. The species is characterized by its more conical shell and the even greater development of the extraordinary callus.
Callodix conica apparently has a very uneven distribution; only two lots, deposited at the Australian Museum in Sydney, are known: that of the holotype, which comes from Darwin, Northern of Australia and a second collected in Okinawa, "Onna Flats", 1.5 km WNW Onna, in Japan. This last lot is, in our understanding, pending confirmation, given the large distance between both locations.

Callodix pseudoconica n. sp.
Fig. 2A-D

Type material. Holotype MNHN-IM-2000-34585 (Fig. 2A-B) and one paratype MNHN-IM-2000-34586.

Material examined. 10 s: South Madagascar, ATIMO VATAE: 1 s, Monseigneur Beach, Stn TM01, 25°02.1-2'S-46°59.9'E, intertidal, rocky bottom with algae; 1 s, Sector of Lavanono, stn BB03, 25°26.4'S-44°56.1'E, 14-18 m, calcareous rocks bulged; 1 s, E Cap Antsirabe, stn TS04, 25°02.3'S-47°00.3'E, 22-24 m, flat rocks and sand with sponges; 2 s, Libanona Beach, stn TB07, 25°02.5'S-46°59.7'E, 4-5 m, corallin rock bottom (holotype and paratype MNHN); 1 s, South of Lokaro Bay, Stn TS09, 24°57.0'S-47°06.4'E, 5-6 m, rocks with sand and mud; 1 s, entrance East of Galions Bay, stn TB10, 25°09.3'S-46°45.3'E, 10 m, brush of rare rocks; 1 s, Flacourt Point, stn TB12, 25°01.5'S-47°00.0'E, 4-5 m, reef bottom; 2 s, W Cap

Antsirabe, stn TS12, 25°02.5'S-46°59.7'E, 4-5 m, rocky bottom in the limit of the reef.

Type locality. South Madagascar, Libanona Beach, 25°02.5'S-46°59.7'E, 4-5 m, coral rock bottom (ATIMO VATAE: Stn TB07).

Etymology. The specific name refers to the similarity with the type species *C. conica*.

Description. Shell very small (<2.00 mm), conoidal, robust, wider than high, basally carinate and not umbilicate.
The protoconch is partially covered by the following whorls, making it very difficult to specify size, number of whorls and ornamentation; however, from what we have been able to see with SEM, the protoconch should have something more than 1 ¼ whorls and a slightly rough surface at embryonic stage.
The teleoconch apparently has 2 whorls and there is not a very sharp basal carina; each whorl almost completely covers the previous one and its entire surface is covered with zigzagging spiral cords and grooves in the interspaces, including the surface of the carina and the umbilical callus.
There are between 40-42 spiral cords distributed between the suture and the umbilical callus.
Aperture oval, prosocline. Parietal area covered by a thick callous layer that is extended adapically until almost completely covering the previous whorl; columella arched, very thick and reflected towards the umbilicus, forming a large columellar callus which occludes it completely; both parietal and columellar callus are covered by spiral cords in zigzag, like the rest of the shell. Outer lip with a smooth margin.
Umbilicus completely covered by the expansion of the columellar callus.
Dimensions: the holotype measures 1.87 mm in diameter and 1.12 mm in height (H/D: 0.60).

Habitat. Infralittoral species collected at 0-24 m in limestone rock overhanging; coral rocky bottom; brushing on rare stones; reef background; slab and sand in Sponges; intertidal, rocky bed with algae; rock with sand and silt and rocky bottom in edge of flat.

Distribution. Only known from Southern Madagascar.

Remarks. *Callodix pseudoconica* n. sp. is characterized by its conoid shape and by the number of the spiral cords on the last whorl.
By its shape it is very similar to *C. conica*, from which it can be distinguished by the higher number of spiral cords and by having a less prominent the basal carinae.
From *Callodix discus*, which was assigned in the genus *Anticlimax* (see Rubio & Rolán, 2014), it may be differentiated by having a higher number of spiral cords and by the lack of a raised area around the umbilicus.

Callodix planata n. sp.
Fig. 3A-D

Type material. Holotype MNHN-IM-2000-34587 (Fig. 3A-B) and one paratype MNHN-IM-2000-34588.

Material examined. 2 s: **South Madagascar**, ATIMO VATAE: 1 s, Pointe Evatra, Stn TB01, 24°59'8S-47°05.7'E, 22 m, rocky bottom, depressions of sand (paratype); 1 s, South Lokaro Bay, TS09, 24°57.0'S-47°06.4'E, 5-6 m, rocks with sand and mud (holotype).

Type locality. South Lokaro Bay, South Madagascar, 24°57.0'S-47°06.4'E, 5-6 m, rocks with sand and mud (ATIMO VATAE: Stn TS09).

Etymology. The specific name derives from the past participle of the Latin verb *plano, as, ari, avi, atum,* meaning "roll flat" and alluding to its adapical part, in which the spire is almost non-appreciable.

Description. Shell very small (<2.00 mm), almost planispiral, robust, much wider than high, not carinated or umbilicated.
The protoconch is partially covered by the following whorls, making it very difficult to specify size, number of whorls or ornamentation; however, from what we have been able to see with SEM, the protoconch should have something more than 1 ½ whorls and, probably, it develops in two phases, but this would need the observation in juveniles.
The teleoconch apparently has 2 whorls and there is no basal carina; each whorl covers the previous one almost completely and its entire surface is completely covered by zigzagging spiral cords and grooves in the interspaces, including the surface of the umbilical callus; the spiral cords are wider than the grooves; the spiral grooves, in the last whorl, are transformed into rectangular spaces.
Base convex, somewhat concave in its umbilical zone.
Aperture oval, prosocline. Parietal area covered by a thick callous layer that extends adapically until covering the previous whorl almost completely; columella arched, very thick and reflected towards the umbilicus, forming a large callus which occludes it completely; both columellar callus are covered by spiral cords in zigzag, like the rest of the shell. Outer lip with a smooth margin.
Umbilicus completely covered by the expansion of the columellar callus

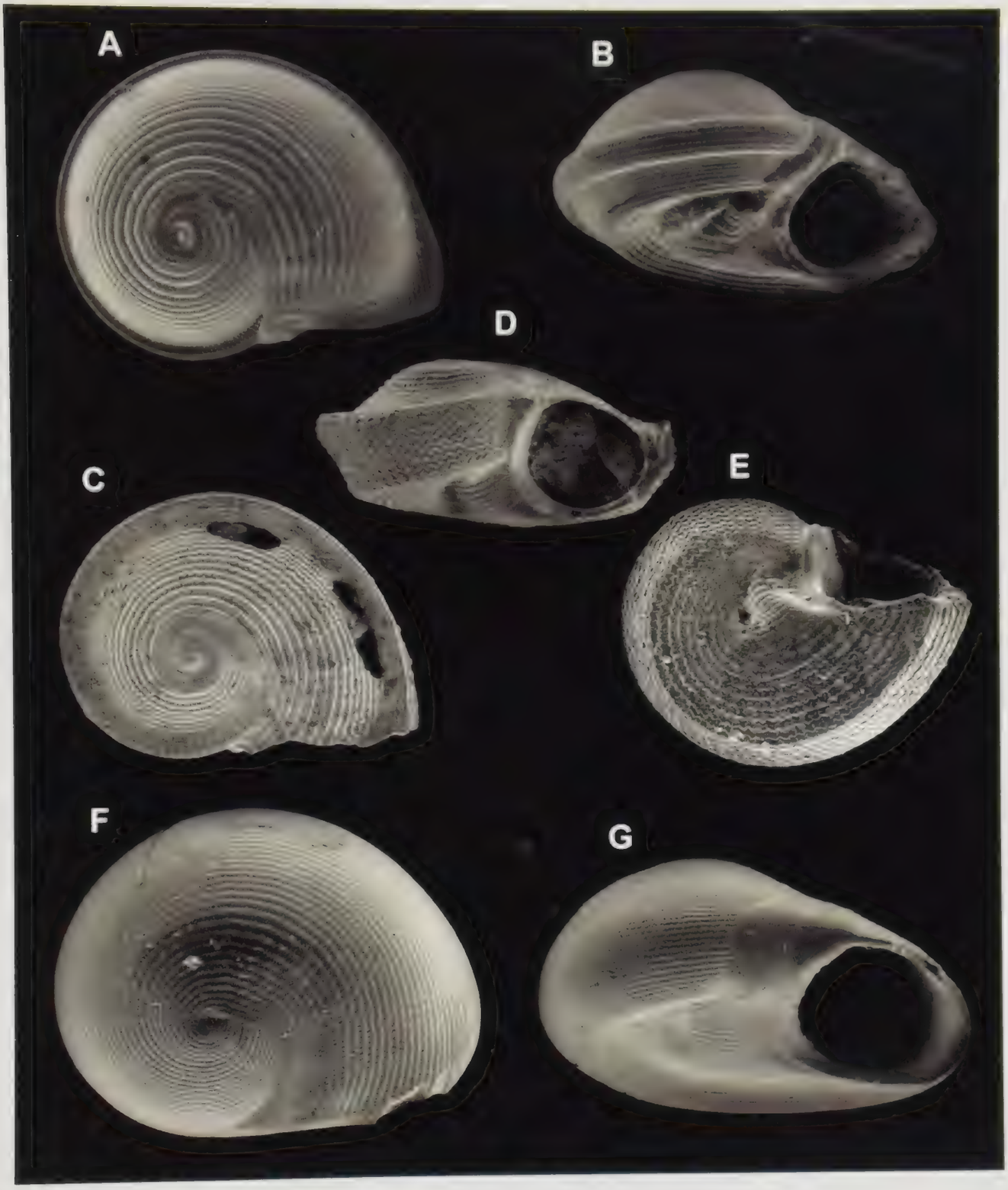

Figure 4
A-B. *Callodix discus* (Rubio & Rolán, 2014), holotype MNHN-IM-2000-27211, 1.78 mm; **C-E.** *Callodix religiosus* (Rubio & Rolán, 2014), holotype MNHN-IM-2000-27216, 1.4 mm; **F-G.** *Callodix juanvianoi* (Rubio & Rolán, 2018), holotype MNHN-IM-2000-33610, 2.3 mm.

Dimensions: the holotype measures 1.7 mm in diameter and 0.65 mm in heigth (H/D: 0.39).

Habitat. Infralittoral species collected at 5-6 m in rock with sand and silt bottom and at 22 m in rocky bottom.

Distribution. Only known from Pointe Evatra and South Lokaro Bay, South of Madagascar.

Remarks. *Callodix planata* n. sp. is characterized by its flat form, almost planispiral and by its protoconch which seems to be developed in two phases.
It is rather similar to *C. solida* in shape but it can be differentiated by the lower number of spiral cords and the apertural form.
From *C. conica*, *C. pseudoconica* n. sp. and *C. discus* it may be separated by its almost planispiral form.

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Monstrotyphis anapaulae n. sp. a remarkable new Typhinae (Gastropoda: Muricidae) from Mozambique

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KEYWORDS. Mozambique, Gastropoda, Muricidae, *Monstrotyphis*, new species.

ABSTRACT. A new species of *Monstrotyphis* Habe, 1961 is described from Mozambique and compared with *M. imperialis* (Keen & Campbell, 1964) and other related species from Oman, Australia and Japan.

INTRODUCTION

The muricid subfamily Typhinae is divided into 19 genera and subgenera. Fourteen of those include Recent as well as some fossil species and five contain only fossil species (Houart 2018). The subgenus *Siphonochelus* (*Choreotyphis*) was forgotten in Houart (2018), however it was previously reinstated by Houart (2013).

Monstrotyphis Habe, 1961 was a monotypical genus until some species were moved from *Typhina*, in which they were originally or later classified, to *Monstrotyphis* (Houart 2002). With the new species described here, this genus now includes 14 species of which 13 are from the Indo-West Pacific and one from the western Atlantic.

Five Recent species of Typhinae occur off Mozambique: *Siphonochelus* (*S.*) *transcurrens* (von Martens, 1902), *S.* (*S.*) *nipponensis* Keen & Campbell, 1964, *S.* (*S.*) *rosadoi* Houart, 1999, *S.* (*S.*) *mozambicus* Houart, and the new species described here.

Material and Methods

Material

The specimens were collected by the second author off southern Mozambique and during the INHACA expedition of MNHN/Universidade Eduardo Mondlane, Maputo, from November 23 to December 12, 2011 in the vicinity of the island of Inhaca (26°S, 33°E).

Methods

The characters used to describe shell morphology address the general aspect of the shell, its shape, size, and colour, the shape of the spire including the number and features of the protoconch and teleoconch whorls, details of the suture and of the subsutural ramp, details of axial and spiral sculpture, the aperture and the siphonal canal.

The method used to determine diameter and height, and to count the number of protoconch whorls follows Bouchet & Kantor (2004) and is shown in Fig. 1. The description is based on the holotype. The bathymetric ranges given herein are the inner values of the recorded depths: the deepest minimum and the shallowest maximum of each recorded depth range.

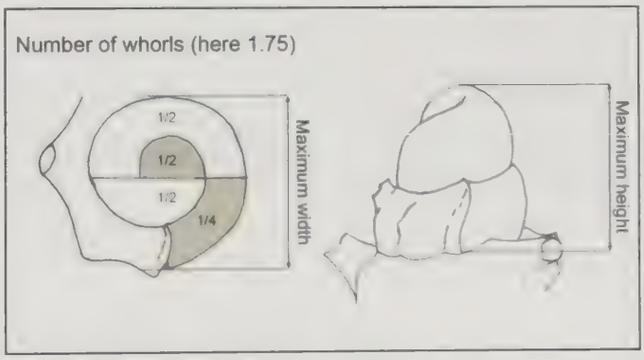

Fig. 1. Method for determining diameter, height and counting the number of protoconch whorls (*Monstrotyphis anapaulae* n. sp., holotype MNHN-IM-2000-31729).

Abbreviations

Repository

CAS: California Academy of Sciences, San Francisco, U.S.A.
JR: Collection of Jose Rosado.
MNHN: Muséum national d'Histoire naturelle, Paris, France.
NSMT: National Museum of Nature and science, Tokyo, Japan.
RH: Collection of Roland Houart.

Others

ad: adult;
dd: empty shell(s);
juv: juvenile;
lv: live collected specimen(s);
P1-P6: primary spiral cords on the convex part of the teleoconch whorl; s5: secondary cord of the convex part of the teleoconch whorl between P5 and P6; ABP: abapertural primary cord on the siphonal canal; MP: median primary cord on the siphonal canal; ADP: adapical spiral cord on the siphonal canal (Fig. 2).

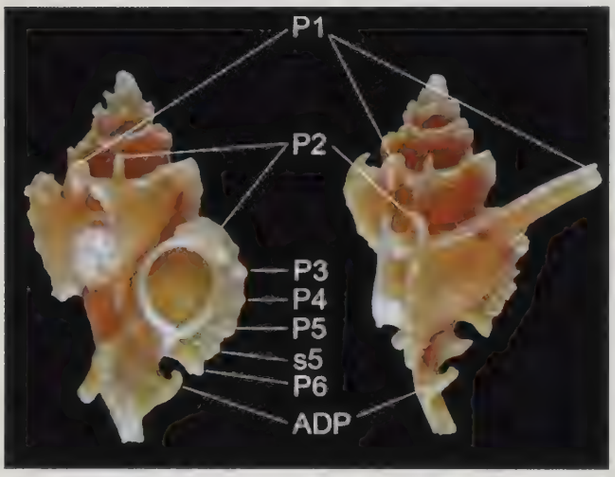

Fig. 2. Spiral sculpture morphology. *Monstrotyphis anapaulae* n. sp. Holotype MNHN-IM-2000-31729

SYSTEMATICS

Family **Muricidae** Rafinesque, 1815
Subfamily **Typhinae** Cossmann, 1903
Genus ***Monstrotyphis*** Habe, 1961
Type species by original designation: *Typhis* (*Typhinellus*) *tosaensis* Azuma, 1960, Japan.

Monstrotyphis anapaulae n. sp.
Figs 1, 2, 3A-L

Type material. Holotype MNHN-IM-2000-31729, South Mozambique, Ponta Mucombo, dredged 180-190 m, lv, ad (12.3 mm).
Paratypes: Mozambique, INHACA, stn MD28, Inhaca Island, NE Ponta do Farol, 25°55' S, 33°07' E, 145 m, 1 lv, juv, MNHN-IM-2017-1261; South Mozambique, Ponta Mucombo, dredged 180-190 m, 1 dd, ad., 1 lv, ad, 1 lv, juv, JR; South Mozambique, Ponta Mucombo, dredged 180-210 m, 1 dd, ad, RH; South Mozambique, Ponta Mucombo, 26°12' S, 33°03' E, dredged 205-218 m, 1 lv, juv, RH.

Type locality. South Mozambique, Ponta Mucombo, 180-190 m.

Distribution. South Mozambique, 25°55' – 26°12' S, living at 145-205 m.

Description of the holotype. Shell of medium size for genus, 12.3 mm in length. Length/width ratio 1.7, broadly biconical, smooth, lightly built. Subsutural ramp narrow, weakly sloping.
Shell light brown; subsutural ramp and anal tube darker coloured; protoconch, abapertural part of axial lamellae and ventral part of siphonal canal lighter coloured. Aperture with whitish columellar lip and outer apertural lip, light tan within..
Spire high with 1.75 protoconch whorls and teleoconch of up to 4.15 whorls. Suture deeply impressed. Protoconch moderately large, rounded; width 800 µm, height 1200 µm; terminal lip high, narrow, weakly opisthocline.
Axial sculpture of teleoconch whorls consisting of 4 low, narrow, webbed, serrated lamellae, abaperturally with 6 crenulations corresponding to P2, P3, P4, P5, s5 and P6 (Fig. 2), adaperturally smooth. P1 spiral cord corresponding to anal tube, P2 shoulder cord ending as short, adapical curved spinelet, P3-P6 and s5 indistinct on shell. Anal tubes rounded, originating near preceding varix, forming an angle of approximately 60° with axis of shell.
Aperture small, rounded, forming a continuous peristome. Columellar lip broadly expanded, erect, smooth. Outer lip erect, smooth within. Siphonal canal moderately long, narrow, weakly dorsally bent, ventrally sealed, with fairly long, narrow, acute, dorsally bent and adapically curved spinelet, corresponding to ADP.
Operculum rounded with concentric ridges and apical nucleus. Radula unknown.

Remarks. The shell morphology of the paratypes is almost identical to that of the holotype, although the last teleoconch whorl may be occasionally slightly broader, with a length/width ratio of 1.8 or 1.9. The ADP spine on the siphonal canal may also be longer and/or more strongly curved upwards.
Monstrotyphis anapaulae n. sp. is similar to the Japanese *M. imperialis* (Keen & Campbell, 1964) currently only known from the holotype (Fig. 3M-O) and from one paratype (Fig. 4), both trawled off Tosa (now Kochi Prefecture), 33°20' N, 133°40' E, in approximately 200 m depth. *M. anapaulae* n. sp. differs from *M. imperialis* in being comparatively smaller in size for a same number of teleoconch

Figure 3 (scale bar 500 µm)

A-L. *Monstrotyphis anapaulae* Houart & Rosado, n. sp.
A-D. South Mozambique, Ponta Mucombo, dredged 180-190 m, holotype MNHN-IM-2000-31729, 12.3 mm; E-H. South Mozambique, Ponta Mucombo, dredged 180-190 m, paratype JR, 7.2 mm; I-K. Mozambique, INHACA, stn MD28, Inhaca Island, NE Ponta do Farol, 25°55' S, 33°07' E, 145 m, paratype MNHN-IM-2017-1261, 7.1 mm; L. Protoconch, South Mozambique, Ponta Mucombo, 26°16' S, 33°03' E, dredged 205-218 m, juvenile paratype RH.
M-O. *Monstrotyphis imperialis* (Keen & Campbell, 1964), Japan, Shikoku, Kochi, Tosa Bay, 33°20' N, 133°40' E, 200 m, holotype Toba Aquarium, TT n° 1013, 16.5 mm, photo courtesy K. Hasegawa.

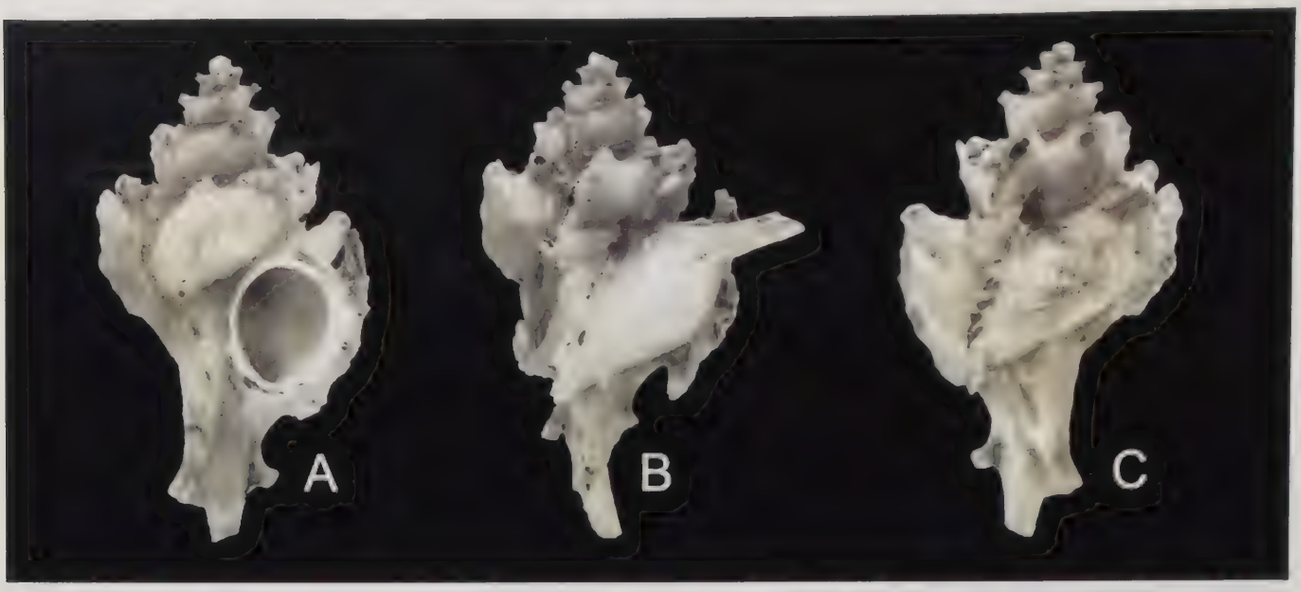

Figure 4
Monstrotyphis imperialis Keen & Campbell, 1964. Paratype CAS 06466. Japan, Shikoku, Kochi, Tosa Bay, 33°20' N, 133°40' E, 200 m, 15.5 mm.

whorls, in having weakly narrower teleoconch whorls, less oblique axial lamellae, almost orthocline in *M. anapaulae* as opposed to the strongly opisthocline lamellae comparatively to the axis of the shell in *M. imperialis*. The siphonal canal in *M. anapaulae* is also shorter and narrower and the distance between P6 and ADP is also remarkably shorter than in *M. imperialis*.

Monstrotyphis imperialis was confused with a New Caledonian species in Houart (1991), but this will be discussed in a forthcoming paper (in prep.). The species was not mentioned in Tsuchyia (2000, 2017) and was considered a synonym of *M. tosaensis* (Azuma, 1960) by Higo et al. (1999). However *M. tosaensis* strongly differs from *M. imperialis* by its high spire, its very long and narrow siphonal canal and a more spiny shell.

Monstrotyphis anapaulae n. sp. also resembles *M. yatesi* (Crosse & Fischer, 1865) (Fig. 5A-C) from South Australia, but differs in having a comparatively smaller size, narrower teleoconch whorls, narrower and strongly adapically curved ADP spine, and narrower, less sloping subsutural ramp.

It also differs from *Monstrotyphis montfortii* (A. Adams, 1863) (Fig. 5D-F) from Japan and the Philippines and *M. takashigei* Houart & Chino, 2016 (Fig. 5G-I) from Japan by its larger size and by its strongly adapically curved and sharp ADP spine while the siphonal canal is spineless in the other species or occasionally with a low, broad ADP in *M. montfortii*. *M. teramachii* (Keen & Campbell, 1964) (Fig. 5J-L) is larger and comparatively narrower with a longer and also spineless siphonal canal.

Monstrotyphis anapaulae n. sp. also differs from *M. goniodes* Houart, Gori & Rosado, 2017 (Fig. 5M-P), a recently described species from Oman, in having a rounded protoconch and a strongly curved, acute ADP spine, as opposed to a strongly keeled protoconch and a siphonal canal with webbed ADP, MP and probably ABP in *M. goniodes*.

Etymology. Named after Ana Paula Pereira, wife of the second author. She has spared no effort to dredge in this area where the sea is generally rough with strong winds and she also sorted the shells.

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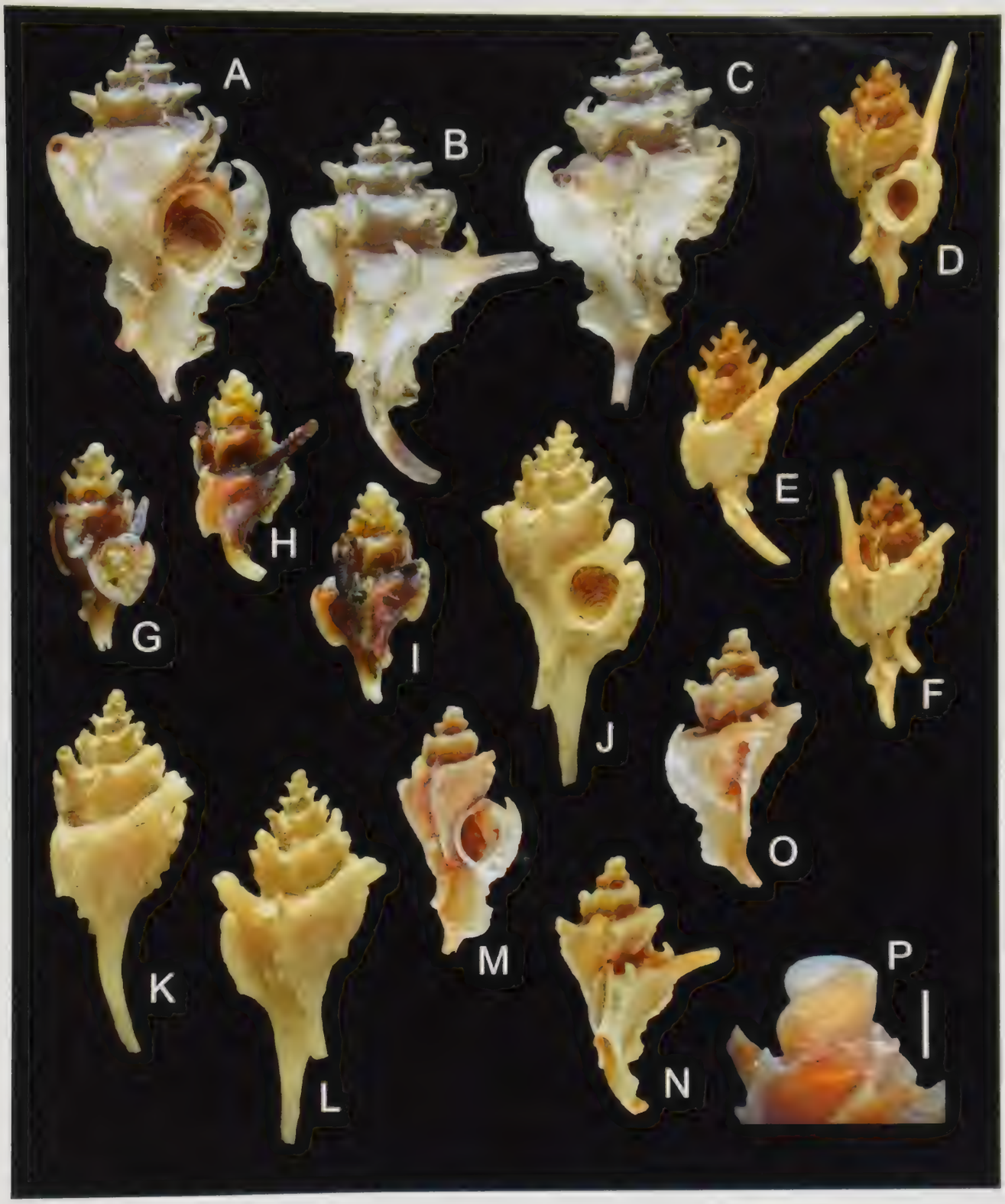

Figure 5 (scale bar 500 µm)

A-C. *Monstrotyphis yatesi* (Crosse & Fischer, 1865), South Australia, Adelaide, Brighton Reef, 14 m, RH, 17.6 mm; **D-F.** *M. montfortii* (A. Adams, 1863), Cebu, Mactan Id, Punta Engano, tangle nets, 50-100 m, RH, 10.0 mm; **G-I.** *M. takashigei* Houart & Chino, 2016, Akino-hama, Izu-Oshima, Izu Islands, Japan, 55 m, holotype NSMT-Mo 78955, 6.4 mm; **J-L.** *M. teramachii* (Keen & Campbell, 1964), Off Tanake, Japan, trawled in 366-421 m, RH, 17.5 mm; **M-P.** *M. goniodes* Houart, Gori & Rosado, 2017, Oman, Dhofar, Mirbat, Deep Plateau, 16°56' N, 54°43' E, 32 m, holotype MNHN IM-2000-33186, 9.5 mm; P. Protoconch.

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A very rare teratological observation in *Monachoides incarnatus* (O. F. Müller, 1774) (Gastropoda: Hygromiidae), a "unicorn snail"

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KEYWORDS. Teratology, *Monachoides incarnatus*, Hygromiidae, unicorn, ommatophore.

ABSTRACT. In April 2017, a double teratological case in an adult *Monachoides incarnatus* (Müller, 1774) was discovered in Liège (Belgium). The specimen constitutes a "unicorn snail", where the snail owns only one central ommatophore (eye-stalk) with two eyes at the top of the tentacle, and a supernumerary small eye close to the right eye. The unique upper stalk is probably due to a trouble in its early development, where the upper ommatophores were abnormally merged. However, the cause and explanation of the third eye remains unexplained. Except for the upper part of the head, this specimen has all the normal characteristic of its species. Even if the specimen has not lost its sense of vision entirely, the visual field could be different. We can suspect a potential handicap to detect the direction of odors. Named 'Cosmo', it was able to produce eggs, unfortunately none have hatched. A succinct review of teratological cases in the soft part of the head in Stylommatophora is introduced and discussed. As far as we know, only one other case of "unicorn snail" was reported from literature in *Helix pomatia*. Another case in *Cornu aspersum* was recently detected in California the same year as our specimen.

INTRODUCTION

Teratological cases are abnormalities of the physiological development in a living being, which can lead to morphological malformation. The causes of these abnormalities are various, with intrinsic (genetic, trouble in ontogeny) and/or extrinsic causes (ex. dietary deficiency, radioactivity, thermal shocks). If these new characteristics are sometimes just cosmetic (ex.: polydactyly in humans) or adaptive [ex.: melanism in butterfly in industrial region (van't Hof et al., 2011; Cook & Saccheri, 2013)], numerous cases can induce severe consequences on the lifestyle and even on the survival of the individual. In the latter case, it can cause a weak adaptation to the normal life of the species (ex.: weak capacity to forage or to avoid predation) or a lethal malformation in the embryonic stage. If in a relatively ancient past, these "monsters" were exploited as an attraction, for Science, teratological cases are primarily an opportunity to better understand the developmental processes and the influences of the environment and of intrinsic factors on these processes.

Among Mollusks, numerous teratological cases were reported. The most famous case is at the origin of the genus name *Cornu* in the Brown garden snail (von Born, 1778). This species was described by Otto Friedrich Müller (1774) as *Helix aspersa* Müller, 1774, and by Jean de Charpentier (1837) as *Helix (Cryptomphalus) aspersus* (*Cryptomphalus* was used as a subgenus). However, before them, Ignaz von Born (1778) described a "horn of plenty" form (an impressive scalariform shell) of the brown garden snail. Thinking to have discovered a new species, he gave the name of *Cornu copiae*. So *Cryptomphalus* Charpentier 1837 is a junior synonym of *Cornu* Born 1778. So today, the teratological name is currently used as the referent to describe this species, despite being in breach of the International Commission on Zoological Nomenclature (Altaba, 2011; Banks, 2012). Numerous other teratological cases were reported in mollusks, mainly concerning the shell shape (e.g. sinistral in dextral species, abnormal color, or again aberrant coiling shape). The "freak" shells, by their rarity and curiosity, have a lot of success among shell collectors. However, other malformations were

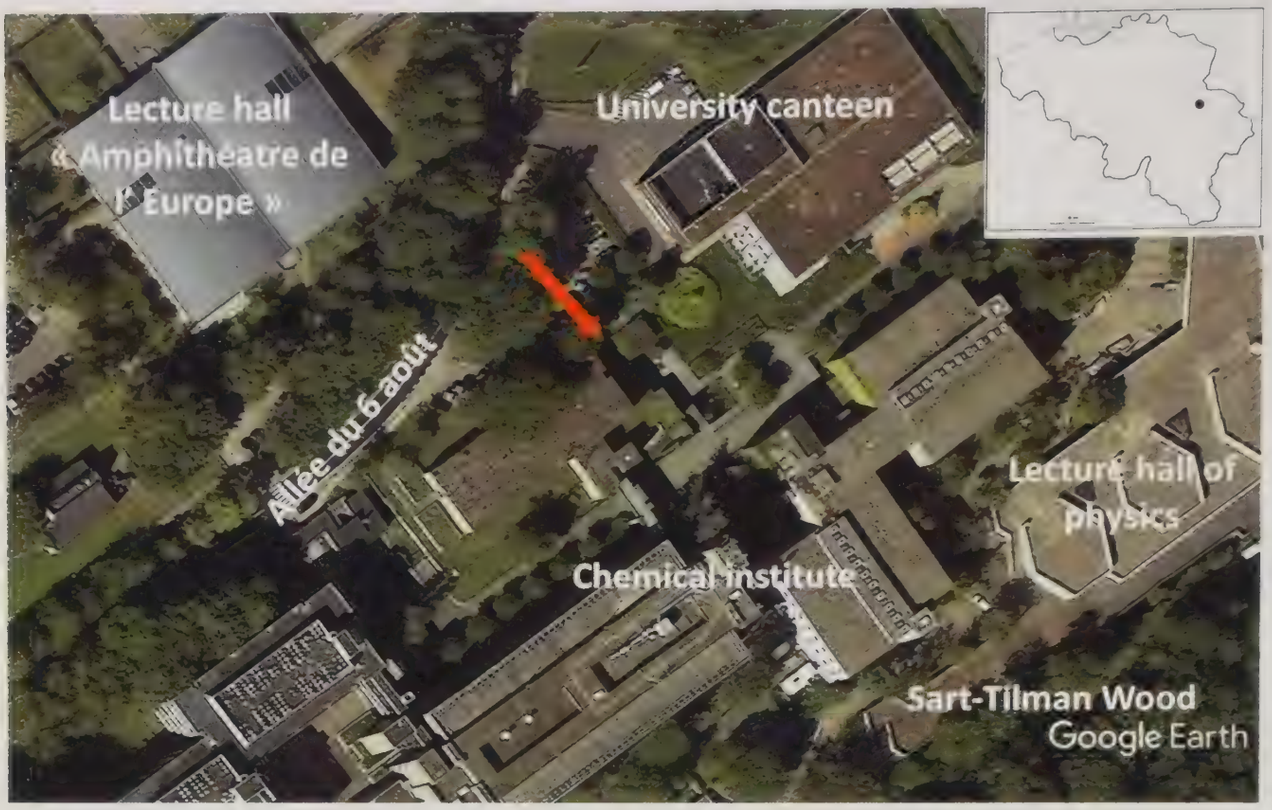

Figure 1. Satellite image (Google Earth 2017) of the south-western part of the Agora District (Campus of Sart-Tilman, University of Liège, Belgium). The red arrow shows the localization where the teratological specimen was discovered.

reported in the soft body (Varga 1993, Mitov et al. 2003: two tails in *Limax punctulatus* Sordelli, 1870), sexual organs [ex. 3 penis in *Rumina decollata* Linnaeus, 1758 (Schmidt, 1855)] and in the shape of the radula (Bor et al. 1994).

CONTEXT OF THE NEW OBSERVATION

On 27th April 2017, the biologist student M. Leclercq discovered in the Sart-Tilman campus (Agora District) of the University of Liège (ULiège, Belgium – Fig.1) a curious gastropod on a step of an outside concrete staircase (50°35'08''N – 5°24'03''E). Her attention was drawn by the curious look of the animal; the gastropod had only one central thick ommatophore. M. Leclercq collected the specimen alive. For the record, M. Leclercq nicknamed the specimen "Cosmo" due to its 'extraterrestrial-like' appearance (in her mind).

DESCRIPTION OF THE SPECIMEN

The specimen was described as a *Monachoides incarnatus* (Müller, 1774), Hygromiidae, living in temperate forests and moist hedges (Welter-Schultes, 2012). It is a very common species in Belgium (Adam, 1960; Vilvens et al. 2012). A recent study on the Sart-Tilman campus (Léonard et al., 2013) have forward that this species is the second more prevalent species observed in the nearby forest after *Discus rotundatus* (Müller, 1774), in term of number as well as spatial abundance. The specimen has a completely developed adult shell (complete aperture) which is 13 mm wide and 8.5 mm high. This is a relatively small size, but still in the normal range of this species [13-16 mm wide and 9-10 mm high (Welter-Schultes, 2012; Kerney & Cameron, 1999)]. Except for the ommatophores, the individual has all the normal external characteristic of the species.

The curiosity of this specimen is clearly the head (respectively the tentacle) (Figs 2-5). If the individual has a small lower pair of stalks as expected, the upper part of the head is totally abnormal. First, the upper pair of eye-stalks (ommatophores) is replaced by a unique merged stalk. This ommatophore is central on the head, and is able to be retracted and to be spread like a normal tentacle. This ommatophore is thicker seen from above (Figs 3 & 4) than in side view, which seems normal in this last point of view (Figs 2 & 4). The animal retains a capacity to angle its ommatophore (at least around 75° from the head axis in horizontal plan, and at least from -45° to 85° in vertical plan) (Fig. 4).

The second interesting characteristic is that two evident eyes are present at the extremity of the eye stalk. Each eye seems connected with a separate optical nerve. However, as this was observed by translucence, we cannot be certain that what was observed was indeed an optical nerve and not a

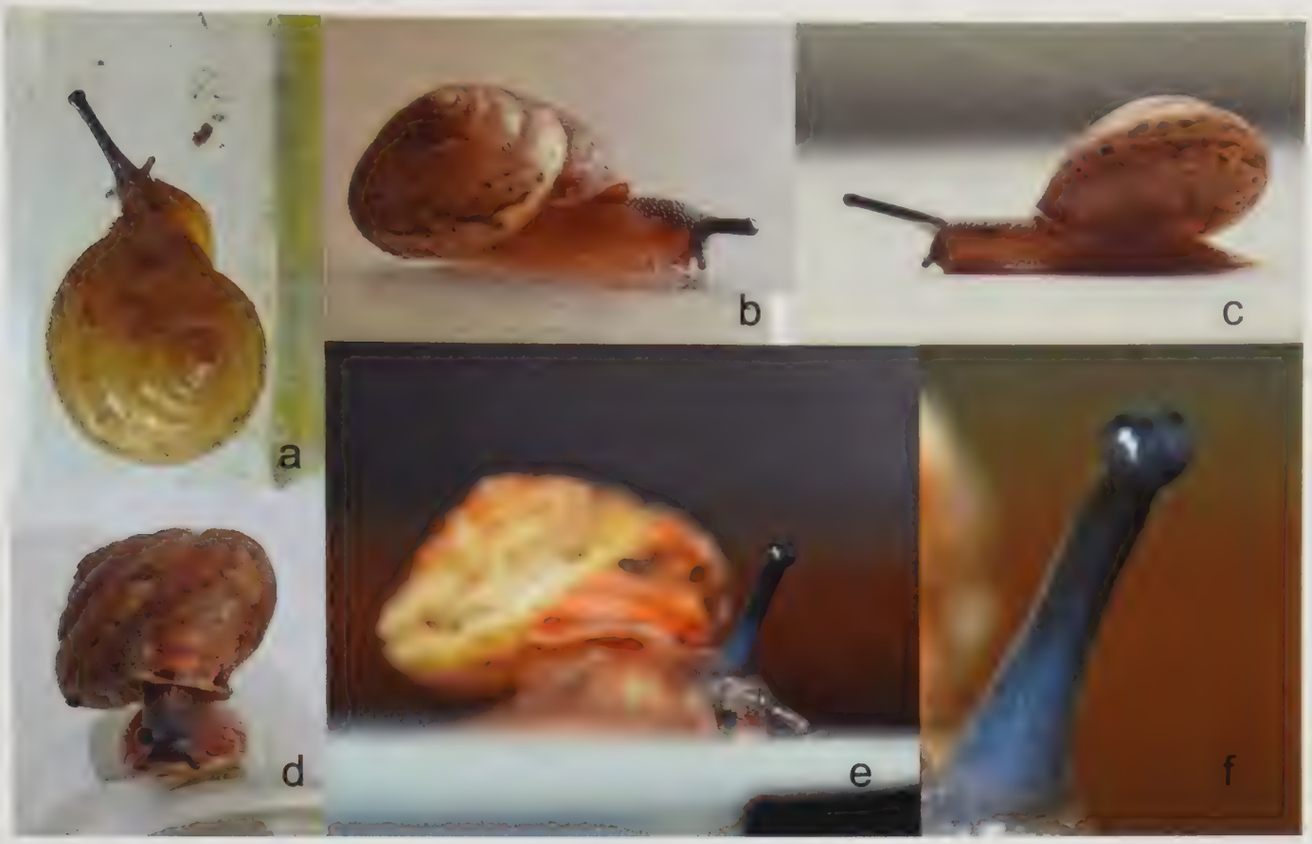

Figure 2. Pictures of "Cosmo", a "unicorn" snail (*Monachoides incarnatus*), in different points of view in day light. Picture 'f' is a magnification of the picture 'e' showing the unique ommatophore with three black ocular spots (a-c: pictures: J.D; d-f: pictures: M.L.).

retractor muscle. So we can assume than this unique central stalk could be a result of a problem in the development of the head, where the two eye-stalks were merged together. However, we are not in the presence of a cyclops case where the fusion is so complete that the eyes are merged in one. Clearly, the extremity of the stalk has a 'horizontal eight' shape like two merged balls, corresponding to the two ocular balls. A closer examination reveals another very uncommon feature: the number of eyes is not two but three! The two main eyes show a normal size for the species, and a smaller third eye is located close to the right eye, slightly under it and in a more central localization (Fig. 5). This third eye also seems to have an optical nerve, but again without being sure that this is not a retractor muscle. We cannot see by translucence whether this structure is connected to or completely independent from the similar one of the right eye.

With one stalk and three eyes, this double teratological case was able to survive with its malformation until the adult age; its handicap was not so severe as to become noxious. Its vision is functional as it shows to retain the capacity to avoid important lighting during our photographic session, notably by contraction of the stalk. However, we can assume that the visual range can differ from that of a normal snail. A normal upper stalk pair has also an olfactory function, and is able to detect the orientation of an olfactory source (tropotaxis) (Chase & Croll, 1981). This capacity is based on the detection of a gradient of olfactory stimulus between the two stalks, the stalk closer to olfactory source perceiving stronger the odor more efficiency. In our specimen, the stalk pair is merged, and remains in central location despite some degree of movement. This specimen could potentially be less performant in detecting the direction of an odor; but suggesting that Cosmo suffered from this handicap remains speculative without histological and olfactive detection experiments. The lower stalk pair, having tactile and olfactory functions, is probably fully functional and carries out the more specific function of analysing stimuli closer to the ground, often by direct contact. We think that the specimen's mouth, and so its capacity to feed, is normal. M.L. was clearly able to feed the specimen with vegetables like slices of cucumber and radish. We have made the choice to not kill the specimen for any dissection.

M. Leclercq has maintained Cosmo in a terrarium with another individual of the same species in the hope that they would pair and produce offspring. If no copulation was observed, Cosmo has spawned the 17th May, around 25 eggs buried by itself in the soil. After four weeks, unfortunately, none hatched. Cosmo died on September 7th, probably in its second year, a normal life span for *M. incarnatus* (Welter-Schultes, 2012).

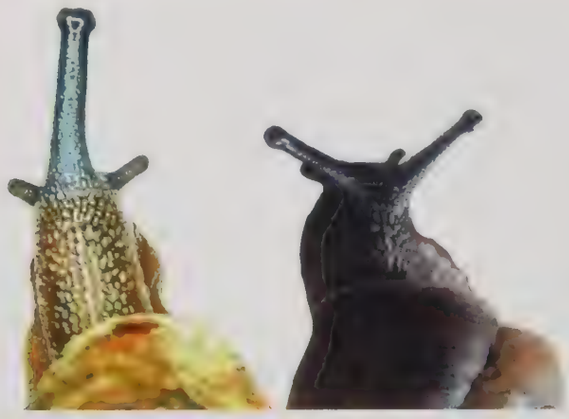

Figure 3. Comparison between "Cosmo" (picture J.D.) and a normal lived adult specimen of *Monachoides incarnatus* (picture C.V.) seen from above.

DISCUSSION

Teratological cases of snail-heads in literature

If malacological literature is rich in teratological cases concerning the shell, few are reported concerning the head and tentacle/ommatophore (reviewed in Table 1 with references). In these rare occurrences, none were reported as lethal embryonic cases. It is logical that a lethal form has few chance to be observed due to the fact that the soft parts of mollusks decompose rapidly, and that the mortality occurs at an early age (the embryos are generally very small and so the malformation remain largely under-detected). Some cases are also reported in snail-breeding forums, but without official scientific reports. An interesting point is the diversity of cases observed in Stylommatophora group, reviewed in Fig. 6 and Table 1.

We can underline a first group of anomalies concerning atypical formation on one eye-stalk, the second one being normal. In this case, an undetermined structure or perhaps an incomplete eye-stalk or tactile stalk can be observed budding from a normal eye-stalk (Fig. 6d-e, Table 1 lines 1, 3, 6-10). In some cases, the eye-stalk can be completely split into two new stalks. In these cases, the snail has three complete eyes. Some pictures in literature seem to show that forked stalks with two eyes are smaller in length than a normal stalk, but others as in Varga (1993) show that this is perhaps just because of a more contracted stalk during a short time, forked stalks retaining the ability to be fully extended as a normal stalk. Another group of anomalies are the 'tricorn' snails (Fig. 6c, Table 1 line 11). Contrarily to the last three-eyed cases, these snails have two normal external eye-stalks, but also develop a central stalk. Unfortunately in our knowledge, no scientific publication reported this case, but pictures from a snail breeding forum suggest a case in *Lissachatina fulica* (Férussac, 1821) with an additional central stalk representing two additional merged ommatophores, and so probably, four eyes in total. This situation is perhaps a case of a partial conjoined twin where a part of the heads of both twins was merged. On the opposite side, another group of anomalies are the 'unicorn' snails (Fig. 6a, table 1 lines 5, 12, 13). In these specimens, only one central stalk is observed. Rotarides (1930) reports in *Helix pomatia* Linnaeus, 1758 a case of such 'unicorn' snail, with two complete eyes at the end of only one larger stalk with two retractile muscles and two optical nerves inside of it. This is clearly a case of coalescence of the two ommatophores very similar to our specimen. In our knowledge, we have not found another case of 'unicorn snail' in literature. However, a recent case has been reported in a *Cornu aspersum* found in a private garden in 2017 in California (USA) (Unpubl. Data, reported on Reddit: https://www.reddit.com/r/mildlyinteresting/comments/77n0rq/a_oneeyed_snail/).

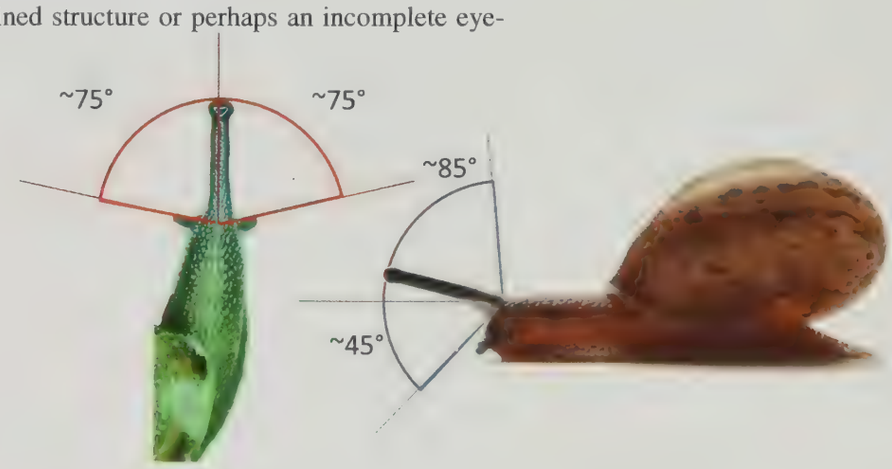

Figure 4. Degree of observed movement of the unique ommatophore in our unicorn snail specimen (*Monachoides incarnatus*). Left: in the horizontal plane, right: in the vertical plane.

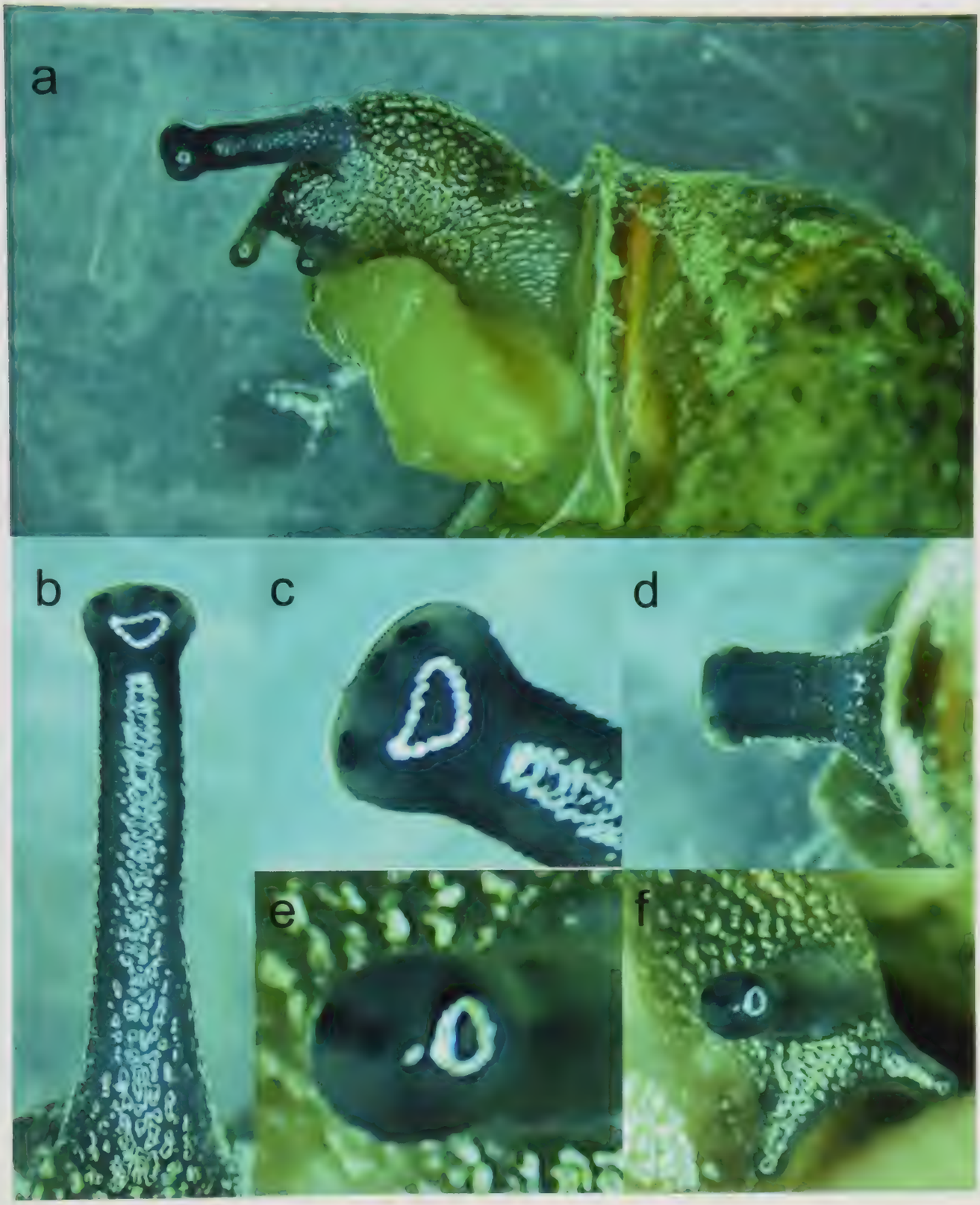

Figure 5. Details of the ommatophore of the "unicorn snail", pictures taken from a binocular microscope. (a): the snail is getting out its shell. (b) above view of the fully extended ommatophore; detail of the extremity of the eye-stalk in upper view (c) and in front view (e & f) and (e) being a magnification of (f). (d): half-contracted ommatophore. (pictures: J.D.).

This garden land snail has exactly the same teratology as our 'Cosmo', but with two normal eyes at the extremity of the merged stalk. The discoverers have kept it as a pet and have given it the name of 'Cyclop'. A similar case was however reported in a *Cepaea nemoralis* (Linnaeus, 1758) where the upper pair are conjunct for half their length, thus forming a fork, like the letter Y (Arkell, 1915) (Fig. 6g, Table 1 line 4). A fourth category of anomalies resides in an abnormal number of eyes without supernumerary tentacles

(Fig.6f, Table 1 line 2). Wiegmanns (1905) reported a snail *Helicella itala* (Linnaeus, 1758) (historically known as *Helix ericetorum* Müller, 1774) with two eyes in one stalk at the level of the ocular globe, with for each one an independent optical nerve.

Potential causes of these teratological cases

Most teratological cases are most probably a consequence of genetic (and/or epigenetic) anomalies having a direct impact on organ ontogeny, or anomalies during regeneration processes after injuries. Other cases resulting from fusion or partial separation such as conjoined twins and chimera will not be discussed here.

When the teratological case has a genetic source, for example a mutated gene, this feature can be transmitted to the next generation. For instance, in *Radix labiata* (Rossmäller, 1835) [(formerly known as *Radix peregra* (O.F.Müller, 1774)], the determination of dextral (normal) and senestral (rare) forms, is based on some genes where determined by maternal effects of a dominant dextral (D) allele and a recessive sinistral (s) allele (Okumora et al. 2008). When the reproduction is based on self-fertilization (land mollusks often being hermaphrodite), the frequency of dextral and sinistral coiling follows the laws of Mendel, but in case of sexual reproduction, with an exchange of gametes from two individuals, the genetic material of the egg is preponderant on the one coming from the spermatozoid.

The sinistral case in gastropods is very interesting because the chirality often induces a reproductive isolation of the mutant population, sinistral and dextral individuals being unable to copulate with each other. This isolation can lead to the creation of new species or sub-species (Okumora et al., 2008). The discovery of teratological mutants can be demonstrated by transmission of this feature to the next generations, which can be observed directly in the next generation if it constitutes a dominant allele.

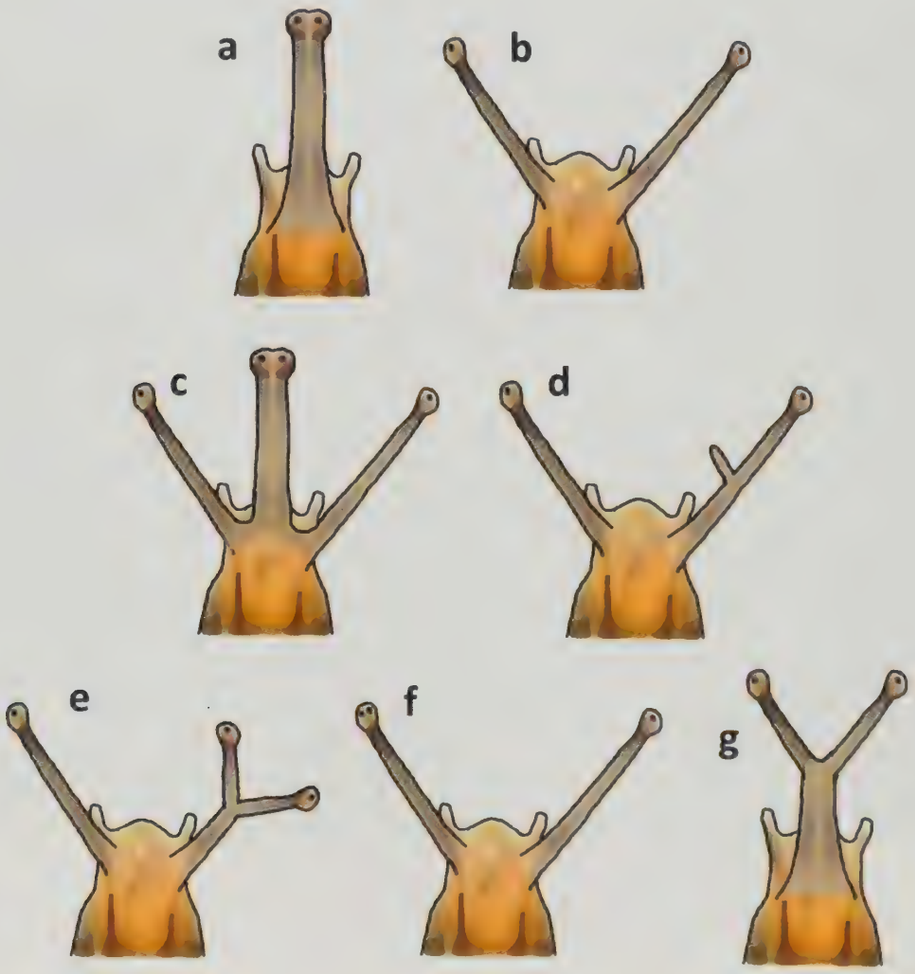

Figure 6. Different types of anomalies observed for the soft part of the head in Stylommatophora. (a) 'unicorn' snail (one thick eye-stalk, two eyes), (b): normal head with an upper pair and lower pair of stalks, (c) 'tricorn' snail (three stalks, two normal external eye-stalks and one central thicker with potentially two eyes), (d) additional body structure on a stalk (can be also a structure similar to a small lower stalk), (e) bifurcation of eye-stalk (with a total of three eyes), (f): supernumerary eyes in one stalk, and (g) 'Y-shaped ommatophore' snail (drawings J.D.).

This is rarer and more complex to observe if the anomaly is due to a recessive allele or due to several different genes, because in this case, several generations can hold the mutant gene without an individual with an abnormal phenotype, as it requires the individual to possess either two recessive alleles if the phenotype is determined by a lone gene, or the correct combination of genes if the anomaly is caused by multiple genes. Another phenomenon is the impact of epigenetics: molecular mechanisms which can control the expression of genes, notably in responses to environmental parameters. In this case, a specific form could appear only in certain environmental conditions due to the activation or inactivation of an epigenetic regulation, and not in other situations despite having the same genome. With all genetic or epigenetic, intrinsic or extrinsic causes, the consequence is a modification of the normal development of organs which can create an aberrant phenotype for the species. Some environmental elements (teratogen agents) can be the source of these modifications: for instance radioactivity or chemical substances can induce mutations in the genome, and/or perturbations in epigenetic regulation, thus creating teratological anomaly.

All the teratological cases are not genetically transmissible. Sometimes, a snail can be observed with a partially or totally absent tentacle. This disappearance is probably the consequence of injury following, for example, predation events. Interestingly, snails are able to regenerate amputated tentacles with the complete and correct morphology (ganglions, muscles and eyes) (Eakin and Ferlatte, 1973; Chase and Kamil, 1983; Flores et al., 1992; Moffet, 1995; Matsuo et al., 2010a,b; Matsuo & Ito, 2011). For a forked stalk, we can imagine that an amputation of this abnormal tentacle can regenerate a new normal one with only one trunk and one eye. On the other hand, when an injury occurs, the regenerative processes can sometimes not work correctly, and an aberrant structure or the duplication of an organ can occur (Mitov et al., 2003).

For our unicorn snail, we have no information as to the cause of its anomalies. It is difficult to imagine an injury event concerning a large part of the head followed by its regeneration. It is more probable than this possesses a genetic (and/or epigenetic) origin during ontogeny, probably in an early developmental stage where the two tentacles were not correctly separated. Unfortunately, we have no explanation concerning the supernumerary right eye.

Table 1. Review of reported teratological cases of the soft part of the head in Stylommatophora

	species	location	type	year and references
1	***Cepaea hortensis***	?	bifurcation (e?)	Hesse 1895 in Varga 1993
2	***Helicella itala***	?	double-eye	Wiegmanns, 1905
3	***Helix pomatia***	?	bifurcation (e?)	Young 1907 in Simroth 1908
4	***Cepaea nemoralis***	England	Y-shaped ommatophore	Arkell, 1915
5	***Helix pomatia***	?	unicorn	Rotarides, 1930 (see also Varga, 1993)
6	***Helix pomatia***	Hungary	bifurcation "d"	Varga, 1993
7	***Helix pomatia***	Bulgaria	bifurcation "d"	Mitov et al. 2003
8	***Cornu aspersum***	California (USA)	bifurcation "e"	2016, unpubl.data nhm.org/nature/blog/mutant-snail
9	***Eobania vermiculata***	?	bifurcation "e"	2016, Unpubl.data youtube.com/watch?v=uuPQllpbOf4
10	***Helix pomatia***	?	bifurcation "e"	Unpubl.data Helix-pomatia.de recited on www.gireaud.net/maladies.htm
11	***Achatina fulica***	?	tricorn	Unpubl.data https://www.petsnails.co.uk/care/breeding.html
12	***Monachoides incarnatus***	Liège, Belgium	unicorn	2017, present study
13	***Cornu aspersum***	California (USA)	unicorn	2017, unpubl.data, comm.pers. reddit.com/r/mildlyinteresting/comments/77n0rq/a_oneeyed_snail/

Comments: "d" & "e" correspond to the different types of bifurcation introduced in Figs 6d & 6e respectively.
Most recent access to the website sources: 10th September 2019.

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NOTE

Première signalisation de *Pelseneeria* Kœhler & Vaney, 1908 (Gastropoda: Eulimidae) sur *Psammechinus microtuberculatus* (Blainville, 1825) (Echinoidea: Parechinidae) à Sesimbra (Península de Setúbal - Portugal)

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MOTS CLEFS. Eulimidae - *Pelseneeria minor* - *Pelseneeria stylifera* - Parechinidae - *Psammechinus microtuberculatus* - Setúbal - Portugal.

KEY WORDS. Eulimidae - *Pelseneeria minor* - *Pelseneeria stylifera* - Parechinidae - *Psammechinus microtuberculatus* - Setúbal - Portugal.

RESUME. Un spécimen de *Psammechinus microtuberculatus* (Blainville, 1825) (Parechinidae) parasité par deux spécimens du genre *Pelseneeria* Kœhler & Vaney, 1908 (Eulimidae) a été récolté à Sesimbra, Península de Setúbal. Cette découverte la plus septentrionale réalisée à ce jour sur la côte du Portugal relance la discussion concernant une population de *Pelseneeria* établie dans le sud de la péninsule ibérique et son attribution spécifique.

ABSTRACT. A specimen of *Psammechinus microtuberculatus* (Blainville, 1825) (Parechinidae) parasitized by two specimens of the genus *Pelseneeria* Kœhler & Vaney, 1908 (Eulimidae) was collected in Sesimbra, Península de Setúbal. This northernmost discovery to date on the coast of Portugal reopens the discussion about a population of *Pelseneeria* established in the southern Iberian Peninsula and its specific attribution.

Un spécimen de *Psammechinus microtuberculatus* (Blainville, 1825) (Echinoidea : Parechinidae) parasité par deux spécimens du genre *Pelseneeria* Kœhler & Vaney, 1908 (Gastropoda : Eulimidae) a été récolté dans un casier de pêche aux poulpes à Sesimbra, Península de Setúbal, Região de Lisboa, Portugal (Fig. A-F). Cette signalisation est la plus septentrionale de la péninsule ibérique en Atlantique et de la côte portugaise en particulier. Jusqu'à présent, une telle association n'avait été signalée que le long des côtes d'Algarve au Portugal et en Mer d'Alboran (Méditerranée occidentale) (Delongueville & al. 2011).

Psammechinus microtuberculatus est un oursin régulier connu avec certitude en Atlantique Nord-Est, depuis le nord du Portugal jusqu'au Cap Vert et le long des côtes nord de la Méditerranée. Il est fréquent en mer d'Alboran et absent du bassin levantin (Froissart et al. 2013). Différentes observations (Delongueville & Scaillet 1999 et Delongueville et al. 2011) font état de la présence de gastéropodes parasites en surface du test de certains individus de cette espèce récoltés entre 20 et 40 mètres de profondeur au Portugal [Algarve : Sagres, Lagos, Alvor (Fig. G-I), Armação de Pêra (Fig. K), Olhão (Fig. J) et Tavira] et en Espagne (Mer d'Alboran : Estepona, Marbella, Fuengirola et Caleta de Vélez) dans des casiers pour la pêche aux poulpes. Ce sont des Eulimidae du genre *Pelseneeria* Kœhler & Vaney, 1908. L'identification du genre est aisée mais celle de l'espèce pose problème (Delongueville et al. 2011). Si on applique la clé de Bouchet & Warén (1986 : 417) aux individus de cette population, ils devraient s'apparenter à l'espèce *Pelseneeria stylifera* (Turton, 1825), à cause de leur surface lisse, de leur columelle de couleur brunâtre et de leur grande taille (jusqu'à 6 mm de hauteur). Ils sont cependant moins globuleux et plus élancés. *P. stylifera* est signalé de la Norvège jusqu'au golfe de Gascogne et ses hôtes identifiés sont *Echinus esculentus* Linnaeus, 1758, *Psammechinus miliaris* (Gmelin, 1778), *Paracentrotus lividus* (Lamarck, 1816) et *Strongylocentrotus species* (Graham 1988 et Bouchet & Warén 1986). *Psammechinus microtuberculatus* n'est pas cité, car

non représenté au nord de la Galice dans l'Atlantique Nord-Est. Il y a donc une discontinuité de distribution entre les populations de *P. stylifera* mentionnées dans la littérature et cette population ibérique.

Par ailleurs, il existe aussi *Pelseneeria minor* Kœhler & Vaney, 1908, une coquille de petite taille (1 à 3 mm de hauteur) signalée en Atlantique Nord-Est (Açores, à 90 m de profondeur et nord-est de Madère à 185 m) sur *Genocidaris maculata* Agassiz, 1869 (Bouchet & Warén, 1986). En Méditerranée, toutes les provenances de *P. minor*, à l'exception de deux, font état de petits spécimens détachés de leur hôte, comme par exemple en mer d'Alboran entre 80 et 200 m, 1,9 mm de hauteur (Peñas et al. 2006) et en mer Tyrrhénienne à 450 m, 1,5 mm de hauteur (Ardovini & Cossignani 1999). Un spécimen récolté en place sur son hôte (*Psammechinus microtuberculatus*) est rapporté de la zone intertidale du sud-est de l'Espagne, il provient de la collection privée de J. Templado (Bouchet & Warén 1986). Ce spécimen sans mention de taille n'est pas figuré. Puisque les auteurs déclarent avoir examiné la coquille, celle-ci devait être petite et ne pas dépasser la taille requise, sans quoi ils ne l'auraient pas nommée *P. minor*. Il n'a pas été possible d'obtenir ce spécimen pour le mesurer, ni pour clarifier le terme « intertidally » définissant sa profondeur de récolte. En 1999, Delongueville & Scaillet rapportent également la collecte de spécimens de *Pelseneeria* sur *Psammechinus microtuberculatus* en province de Málaga. Trompés par leur petite taille, ils les ont attribués à *P. minor*. Des récoltes ultérieures de spécimens beaucoup plus grands (jusqu'à 6 mm de hauteur), trouvés aux mêmes endroits et sur le même hôte, les amènent à les rapprocher plutôt de *P. stylifera*. Il est probable que le spécimen de Templado attribué lui aussi à *P. minor* soit un spécimen juvénile apparenté à la même population ibérique dont il est question ici.

Si cette démonstration exclut l'appartenance des spécimens ibériques à l'espèce *P. minor* telle que décrite par Bouchet & Warén (1986) cela ne permet toujours pas de les attribuer avec certitude à l'espèce *P. stylifera*. Soit il s'agit d'une espèce non décrite, propre aux alentours du détroit de Gibraltar, soit il s'agit d'un écophénotype avec un morphe particulier lié à des conditions particulières de milieu constituant une population méridionale de *P. stylifera* géographiquement séparée de celles connues entre la Norvège et le golfe de Gascogne, soit encore d'un écophénotype de grande taille de *P. minor*. Enfin, s'agit-il d'une seule et même espèce très variable ? Du matériel issu de cette population a fait l'objet de prélèvement et d'analyse d'ADN, mais en l'absence d'identifiants génétiques de *P. stylifera* et de *P. minor*, aucune conclusion n'a pu être tirée à ce jour. Des études génétiques complémentaires devraient permettre de solutionner le problème.

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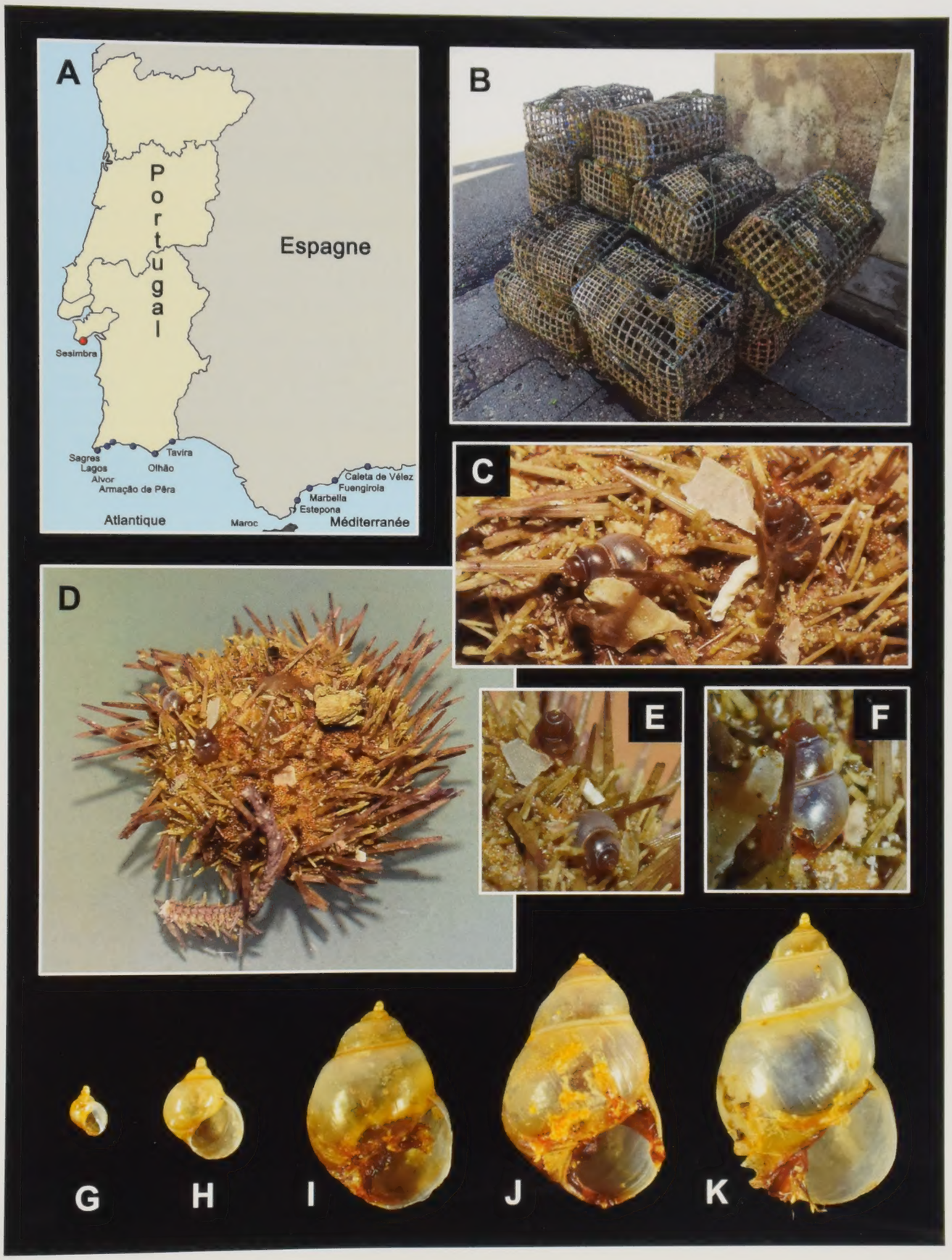
Figure 1

A. Position géographique des lieux de récolte; **B.** Casiers de pêche aux poulpes à Sesimbra, Portugal; **C-F.** *Pelseneeria* sp. (3,9 et 4,2 mm) sur *Psammechinus microtuberculatus* (31,0 mm) à Sesimbra; **G-K.** *Pelseneeria* sp. en Algarve, Portugal. G-I. Alvor. G. 1,0 mm. H. 1,7 mm. I. 4,2 mm. J. Olhão, 5,5 mm. K. Armação de Pêra, 6,0 mm.


A
Portugal
Espagne
Sesimbra
Sagres
Lagos
Alvor
Armação de Pêra
Olhão
Tavira
Caleta de Vélez
Fuengirola
Marbella
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B
C
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